

A Few Words First

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Phone connections may be muted during presentation. Put questions in chat box.

Upcoming Meetings:

- June 12: Enterprise Data Management for Systems of Systems (SoS) – Barbara Mills, Sandia National Laboratories
- July 10: Systems Engineering for Early Stage R&D Projects – Heidi Hahn, Los Alamos National Laboratory, and Ann Hodges, Sandia National Laboratories

CSEP Courses by *Certification Training International*:

Course details(with more locations and dates)

Upcoming Course Schedule (somewhat nearby):

2019 Aug 12-16 | Austin, TX

Chapter SEP mentors: Ann Hodges alhodge@sandia.gov, Heidi Hahn hahn@lanl.gov

First slide, not retained in recording but retained in pdf presentation.

And now - introductions



Enchantment Chapter Monthly Meeting

8 May 2019 – 16:45–18:00 MT

System of Systems (SoS) Managerial and Operational Affinity

Dr. Mike Yokell, Lockheed Martin, Fellow and Deputy Director, Systems Engineering

Abstract: Two key characteristics of systems of systems are operational and managerial independence. But what do these terms really mean, and what am I supposed to do about it? This presentation is a dialogue about assessing the operational relationships between the constituent systems within a system of systems, and the managerial relationships between the organizations that own them. For each of the relationship types, or affinity options, a framework for tangible, actionable guidance is offered.

Download slides today-only from INCOSE_GMSeven file library or any time from the Library at www.incose.org/enchantment

NOTE: This meeting will be recorded

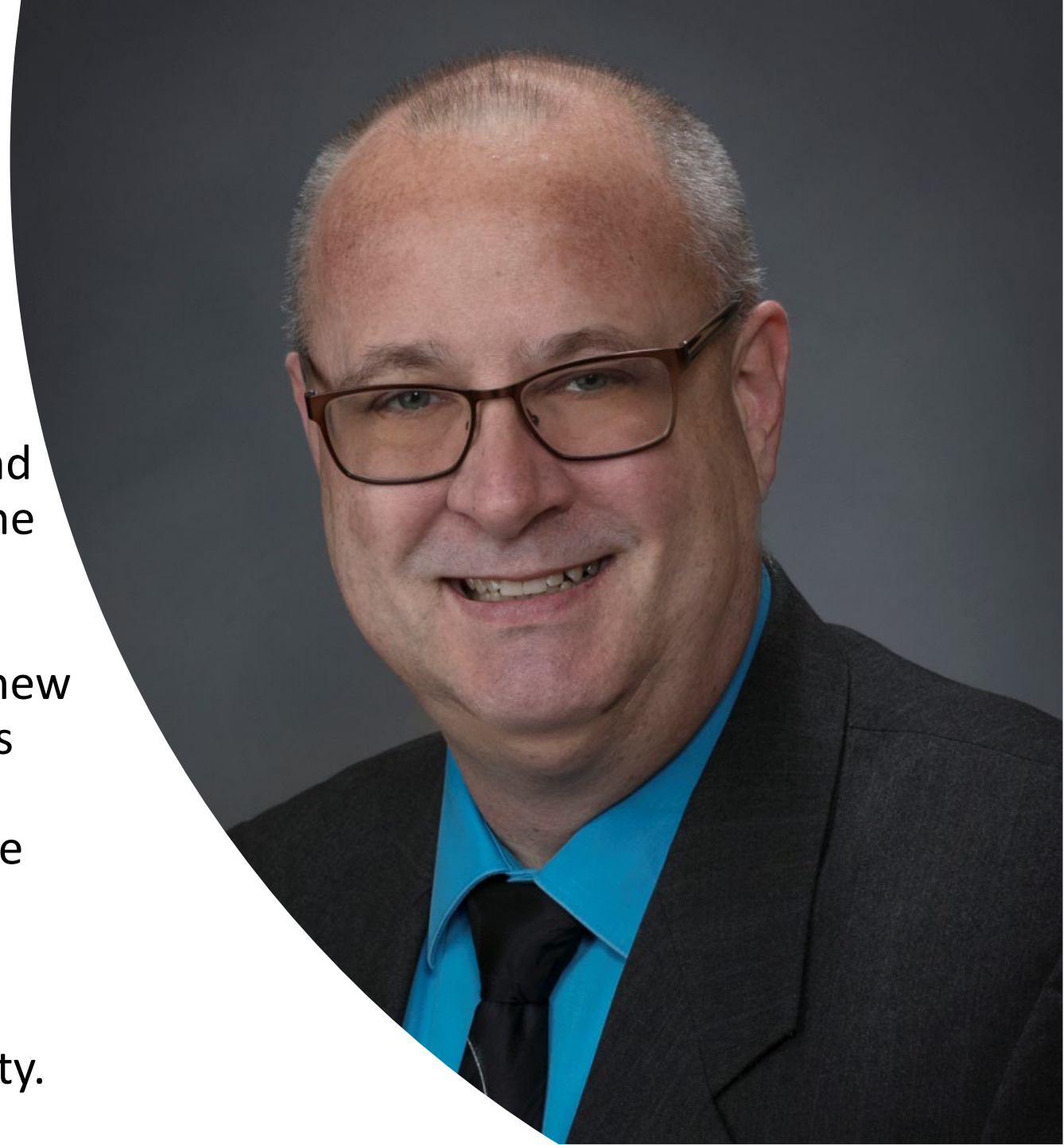
Today's Presentation

Things to think about

- How can this be applied in your work environment?
- What did you hear that will influence your thinking?
- What is your take away from this presentation?

Speaker Bio

Dr. Mike Yokell is a Lockheed Martin Fellow and Deputy Director, Systems Engineering. He is the US representative to International Standards setting bodies for Systems and Software Engineering and is the project editor for two new international standards on Systems of Systems Engineering. Mike is certified as an expert systems engineering professional (ESEP) by the International Council on Systems Engineering (INCOSE). He holds multiple US and European Patents for Model Based Systems Engineering (MBSE) and large scale immersive virtual reality.



SYSTEM OF SYSTEMS (SOS) MANAGERIAL AND OPERATIONAL AFFINITY

ASSESSING AND IMPROVING RELATIONSHIPS WITHIN SYSTEMS OF SYSTEMS

INCOSE Enchantment Chapter, 8 May 2019

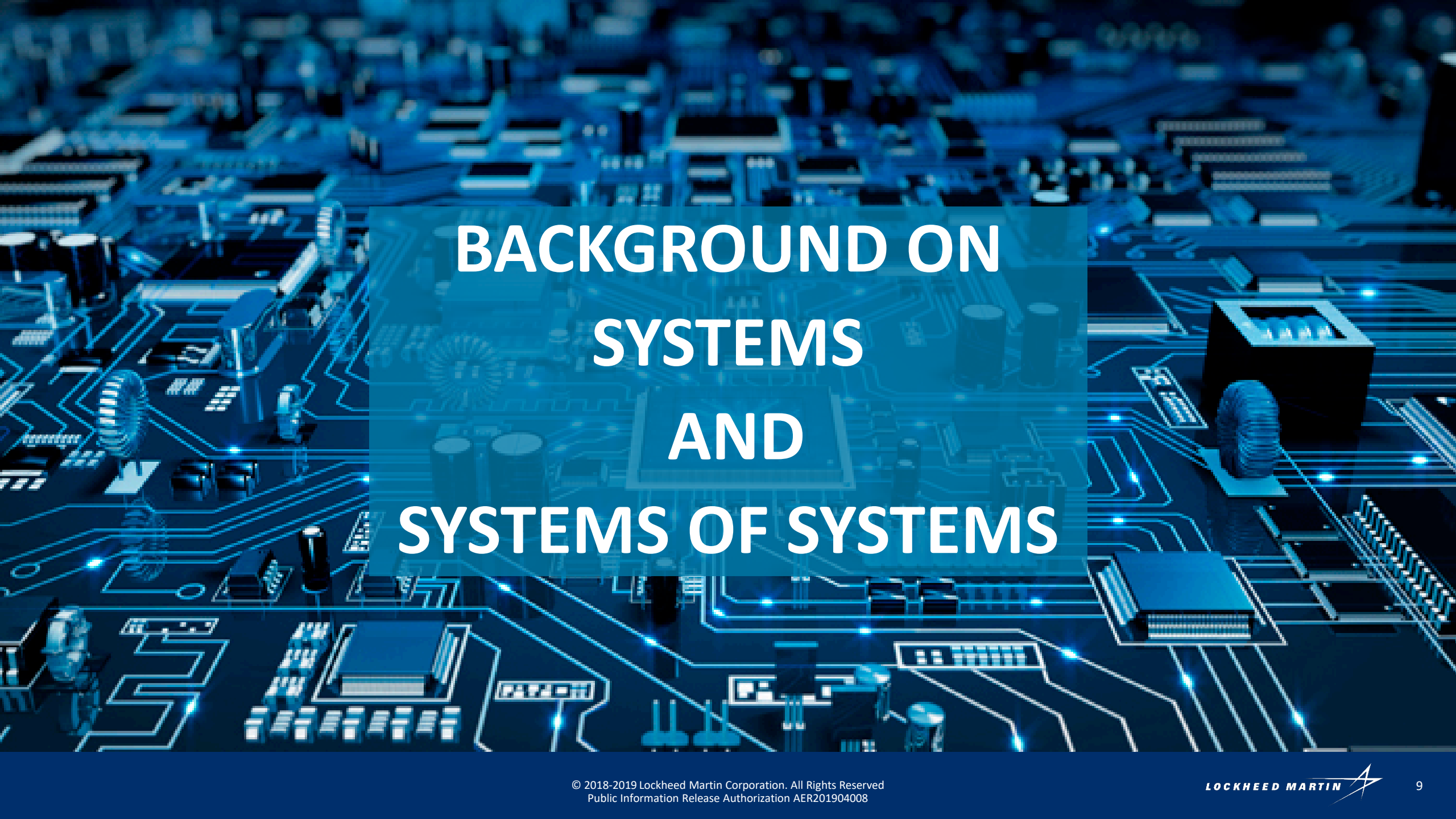
Dr. Mike Yokell, ESEP

Lockheed Martin Fellow and Deputy Director, Systems Engineering



OUTLINE

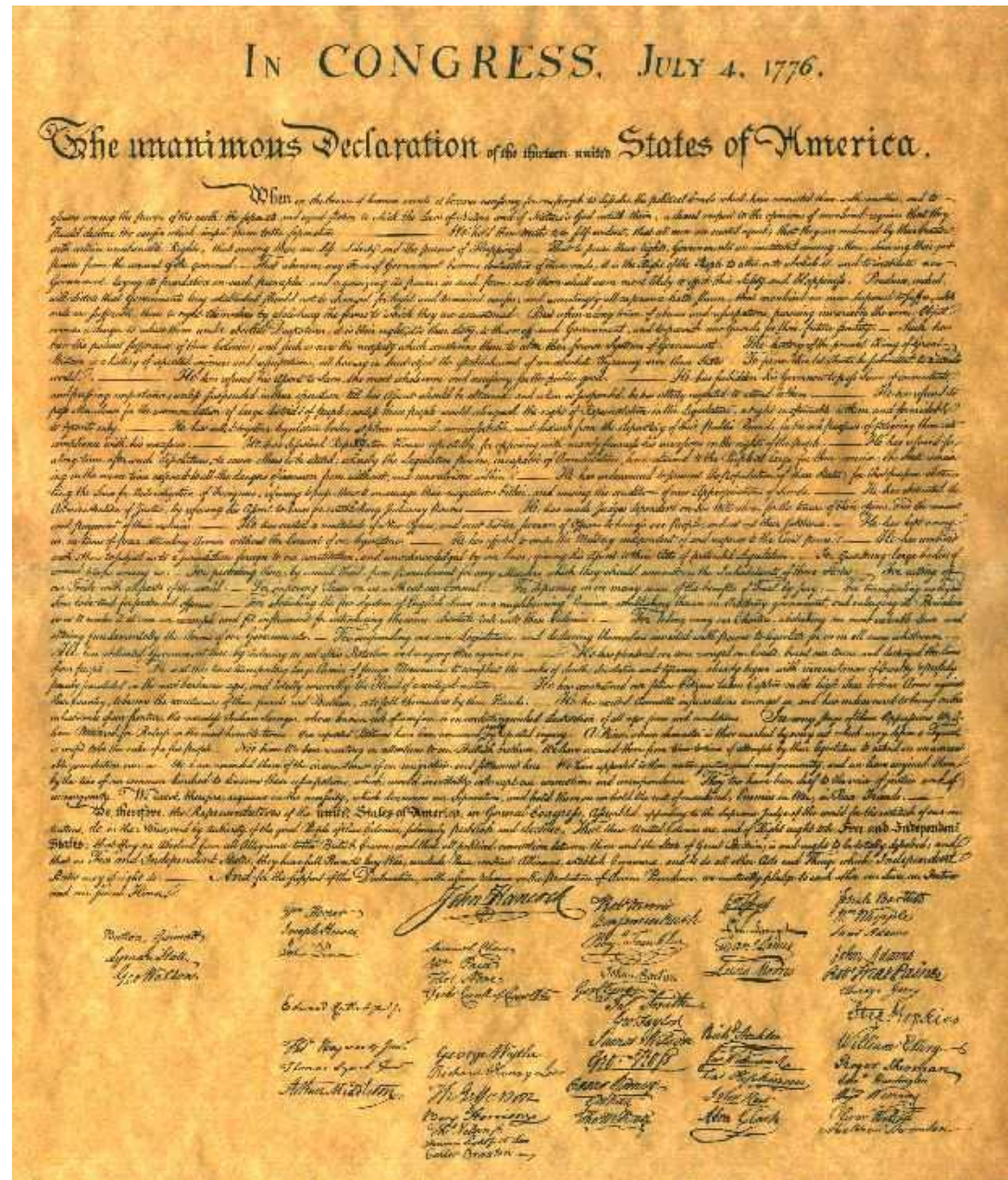
- Background on Systems and Systems of Systems
- Defining the Relationships
- SoS Operational Affinity
- SoS Managerial Affinity
- Summary and Additional Observations



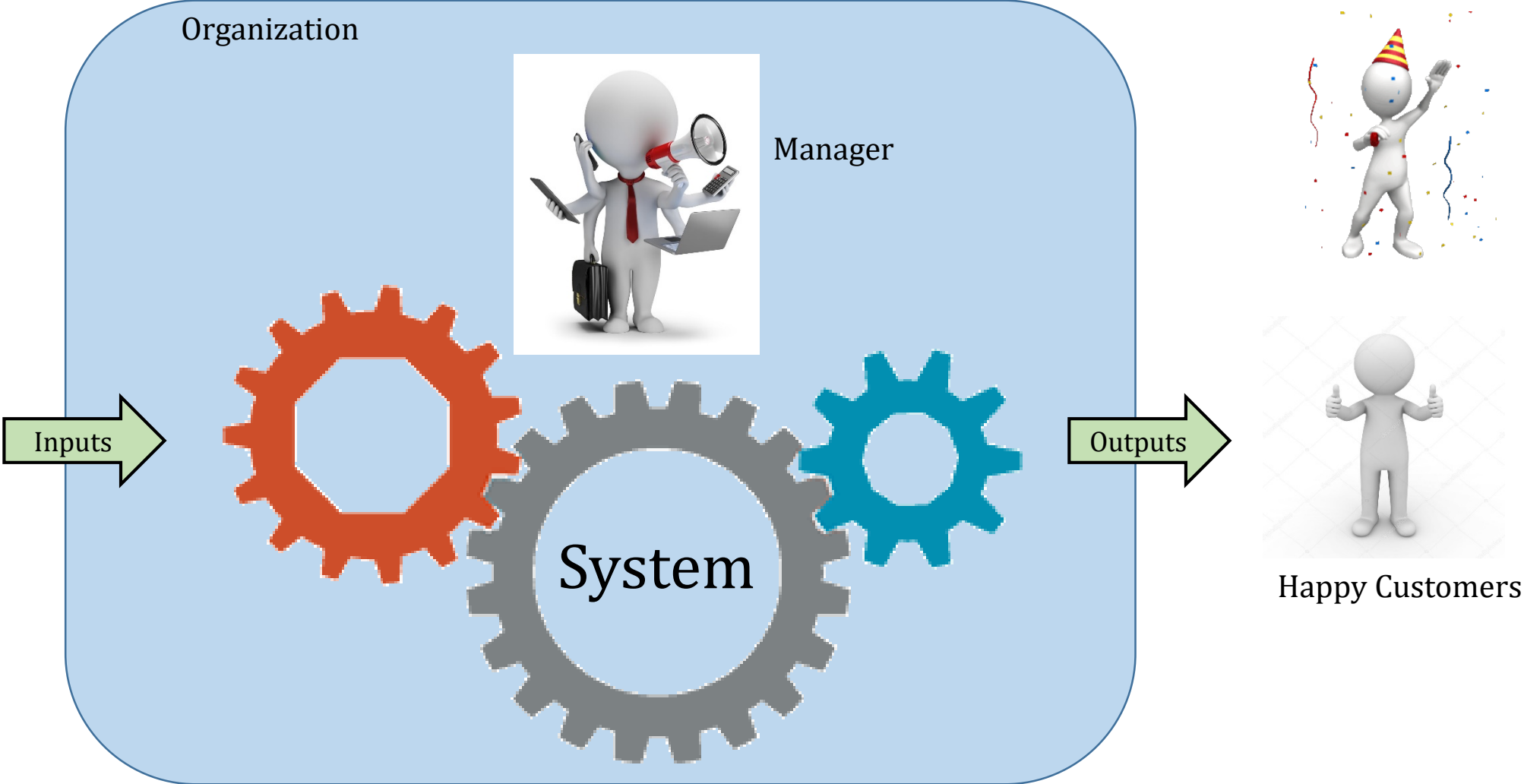
BACKGROUND ON SYSTEMS AND SYSTEMS OF SYSTEMS

MOTIVATION

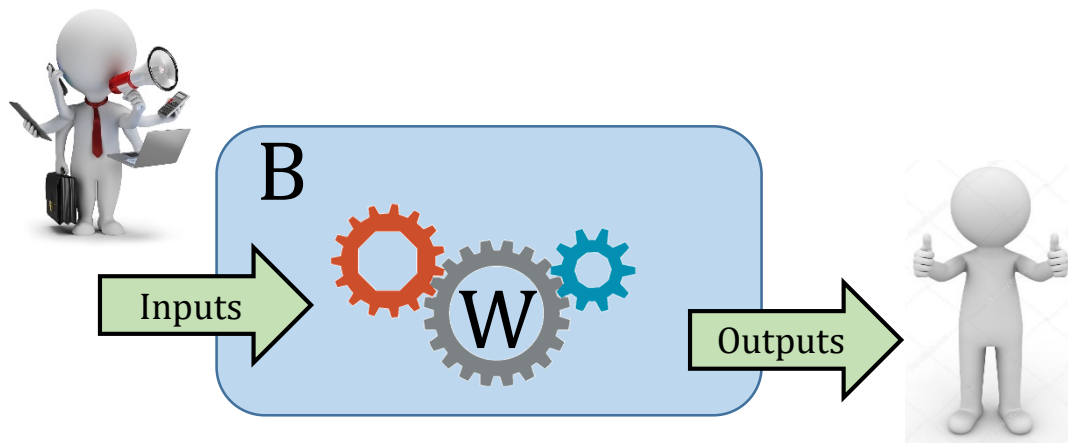
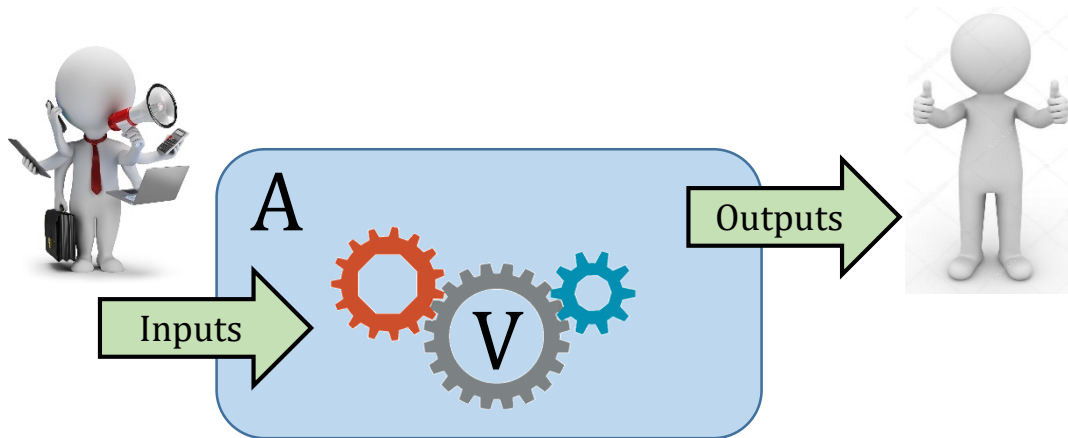
- According to Maier [1], two key characteristics of SoS are
 - Managerial Independence
 - Operational Independence
- What do these mean?
 - Binary (dependent/independent)?
 - Or a spectrum?
- Once categorized, now what?
 - Need some tangible, actionable guidance



SYSTEMS AND MANAGERS



TWO SYSTEMS



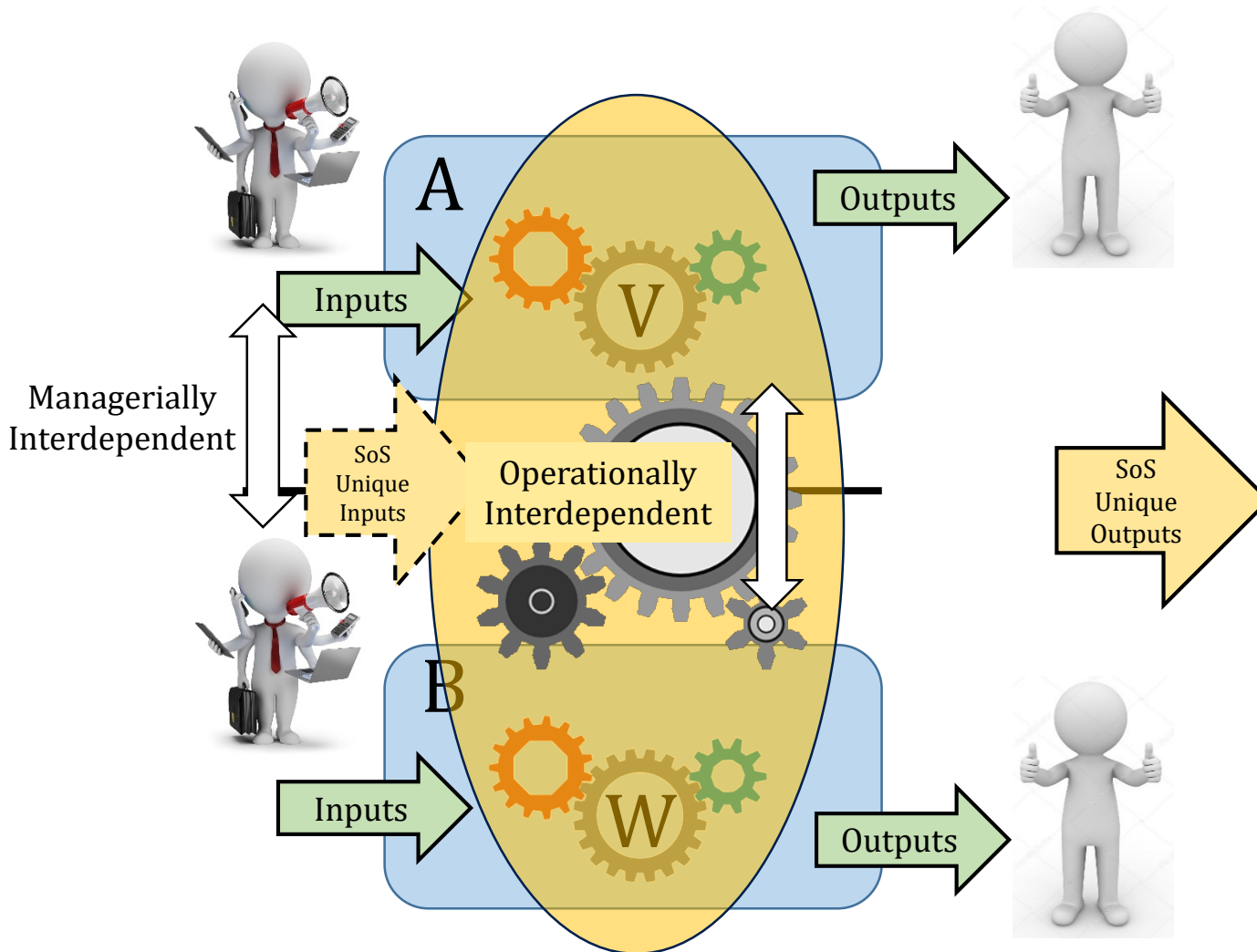
- Systems V and W
 - Operationally Independent
 - Organizations A and B
 - Managerially Independent
- = Two Systems
- System W
 - System V
 - Not SoS

SYSTEM OF SYSTEMS

SoS = set of systems and system elements that interact to provide a unique capability that none of the constituent systems can accomplish on its own.

Note: System elements can be necessary to facilitate interaction of the constituent systems in the system of systems.

[SOURCE: ISO/IEC/IEEE 21839]



- Systems V and W
 - Operationally Independent
 - Operationally Interdependent
 - Organizations A and B
 - Managerially Independent
 - Managerially Interdependent
- = Three Systems
- System W
 - System V
 - SoS WV (or VW)

DEFINE THE RELATIONSHIPS



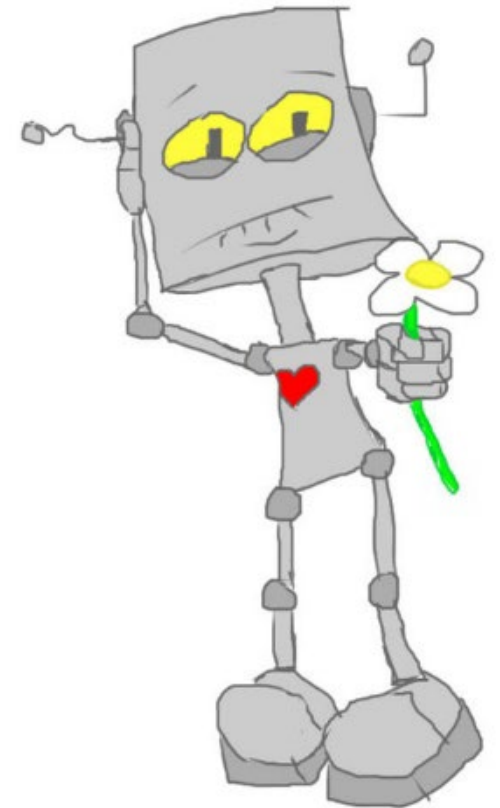
DTR

DTR

[dee-tee-ahr] *verb*

**1. define the relationship;
the uncomfortable talk no
one wants to have about
their dating status.**

#awkwardslangtionary



DEFINITIONS

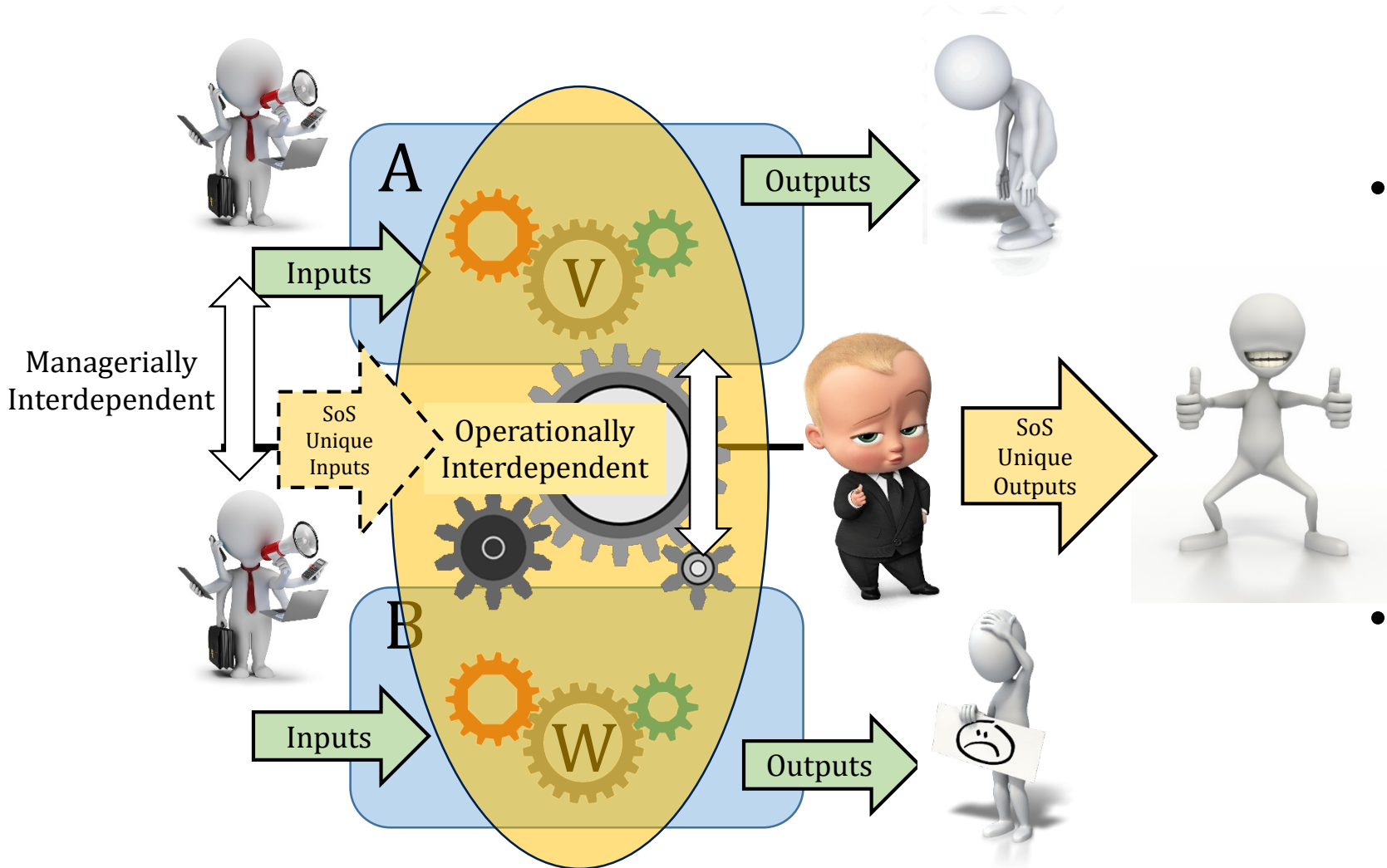
- Affinity
 - The fact of and manner in which something is related to another. (Wiktionary.org)
- Affinity (sociology)
 - shared interest and commitment between persons in groups and/or willingness to associate (Wikipedia.org)
- Relationship
 - A way in which two or more people behave and are involved with each other (Wiktionary.org)



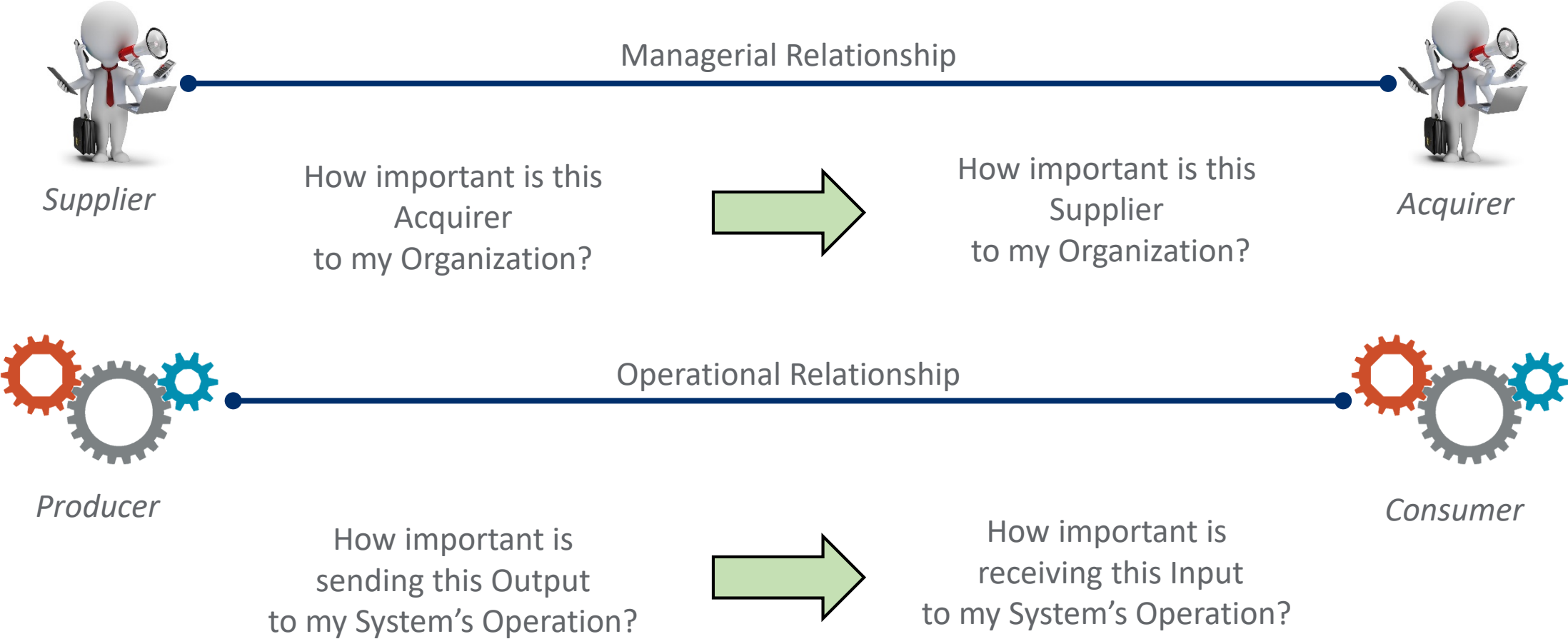
NEED FOR SOS AFFINITIES

- Recall: Organizations may establish priorities for their systems

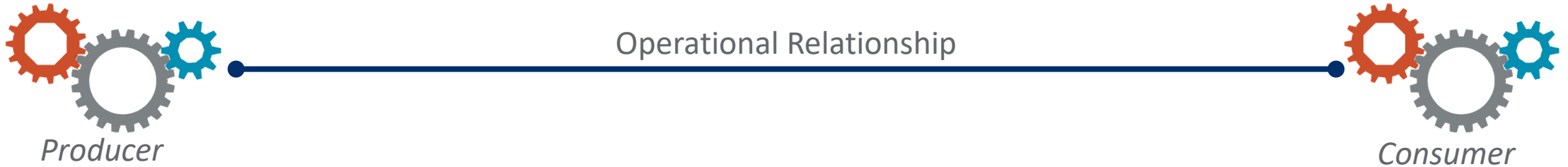
- If the organizations have common goals and objectives
 - Perhaps they might be willing to work together
 - Provide new SoS outputs in addition to their own
- What if they don't?



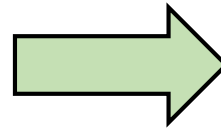
SOS RELATIONSHIPS



DTR: OPERATIONAL RELATIONSHIP

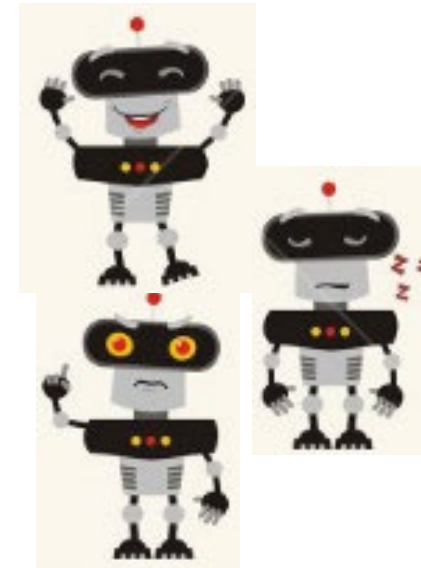
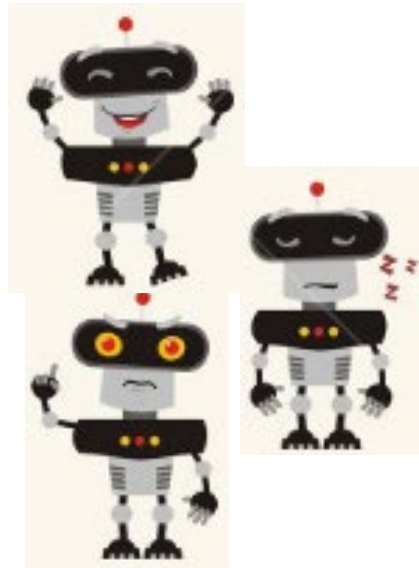


How important is sending this Output to my System's Operation?



How important is receiving this Input to my System's Operation?

Rating	The other system's inputs or outputs are:	Rating
2	Highly important to my system in a positive way	2
1	Somewhat important to my system in a positive way	1
0	Not important to my system	0
-1	Somewhat important to my system in a negative way	-1
-2	Highly important to my system in a negative way	-2



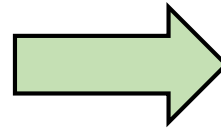
DTR: MANAGERIAL RELATIONSHIP



Managerial Relationship



How important is this Acquirer to my Organization?

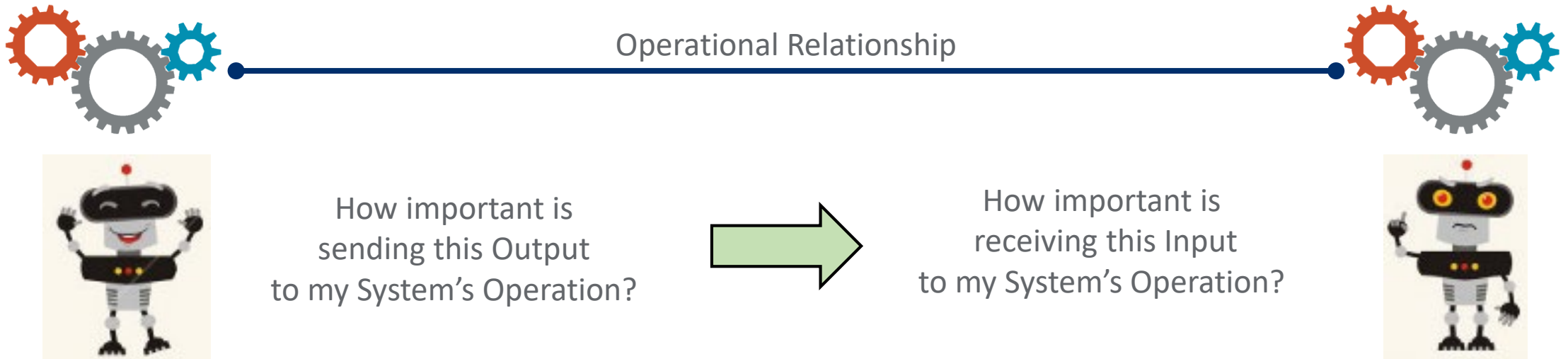


How important is this Supplier to my Organization?

Rating	The other organization's priorities and incentives are:	Rating
2	Strongly aligned to my organization's in a positive way	2
1	Somewhat aligned to my organization's in a positive way	1
0	Not aligned to my organization's	0
-1	Somewhat aligned to my organization's in a negative way	-1
-2	Strongly aligned to my organization's in a negative way	-2

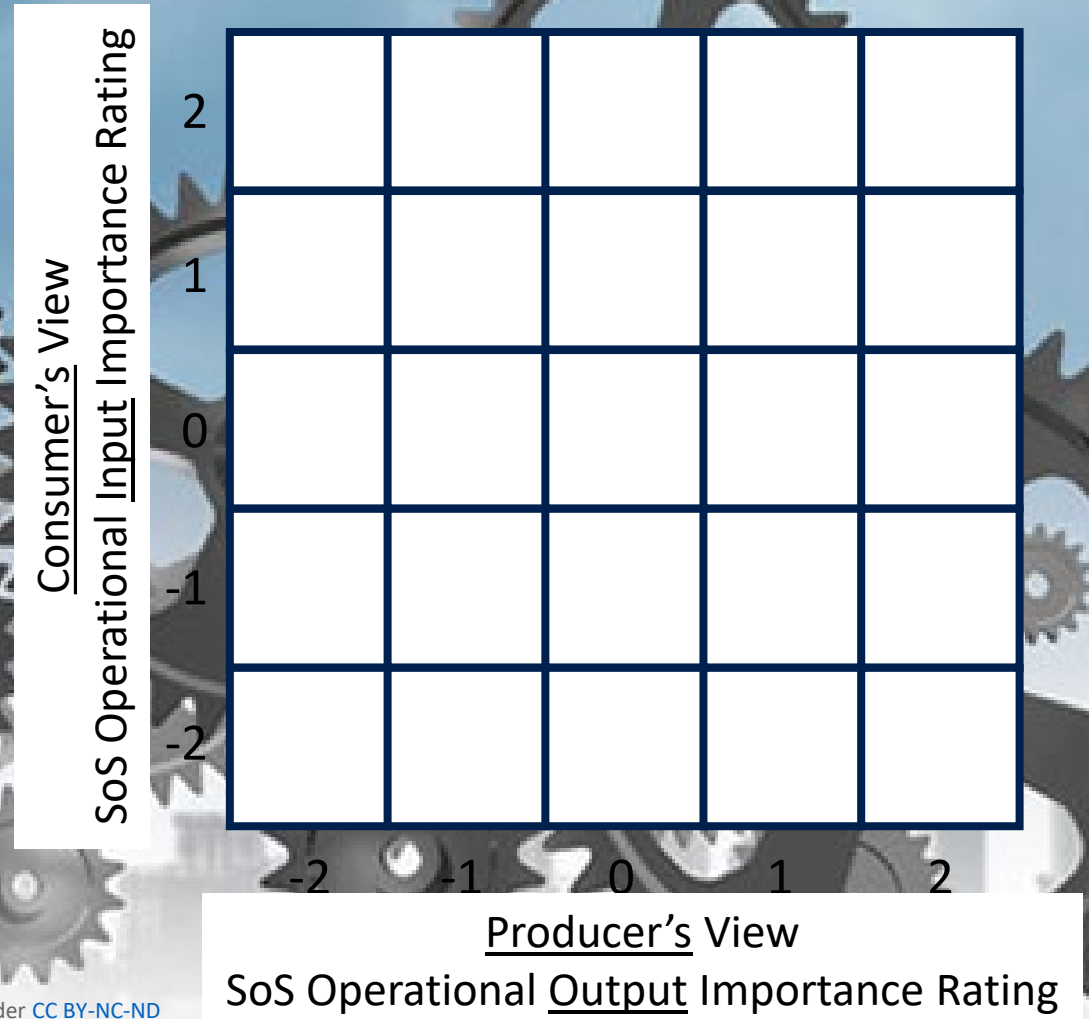


SOS OPERATIONAL AFFINITY



SOS OPERATIONAL AFFINITY

- Map the Consumer's View to the Producer's View
- 5 by 5 matrix



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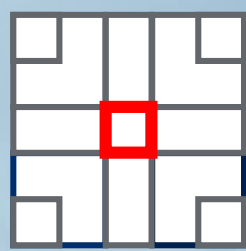
SOS OPERATIONAL AFFINITY

Symbiotic
Cooperative
None
Hidden Consumer
Hidden Producer
Unwanted Consumer
Unwanted Producer
Antagonistic
Freeloader
Spammer
Toxic

Consumer's View
SoS Operational Input Importance Rating

Free-loader		Hidden Happy Consumer	Symbiotic
	Unwanted Consumer		Cooperative
	Hidden Angry Producer	None (No Affinity)	Hidden Happy Producer
	Antagonistic	Hidden Angry Consumer	Unwanted Producer
Toxic			Spammer

Producer's View
SoS Operational Output Importance Rating

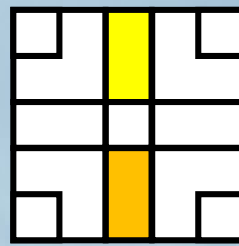


NONE

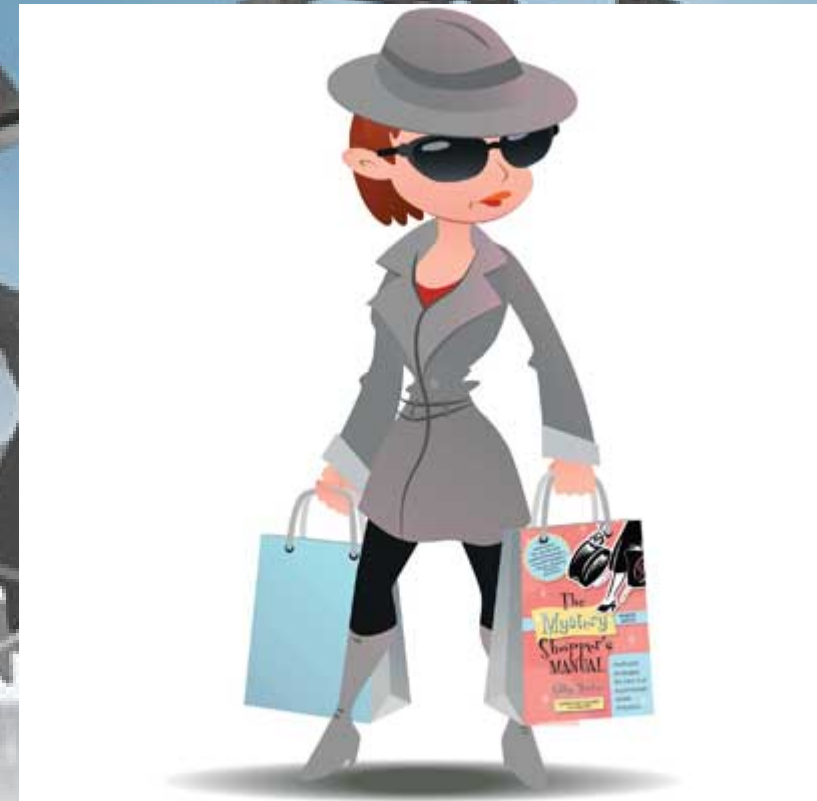
- **Meaning:** Both the producer and consumer agree that there is no relationship.
- **Implications:** Because the lack of affinity has been confirmed, there should be no implications. This relationship should produce no emergent behaviors.
- **Guidance to Producer:** Monitor the relationship for changes over time.
- **Guidance to Consumer:** Monitor the relationship for changes over time.



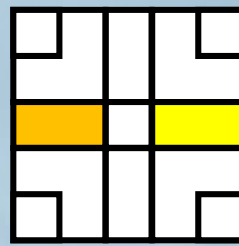
HIDDEN CONSUMER



- **Meaning:** The producer thinks that the outcome is not being used by a given consumer, but the consumer is actually consuming the outcome.
- **Implications:** If the outcome is a shared resource across multiple consumers (e.g., fixed capacity or throughput, such as water, computing power or network bandwidth), consumers could adversely affect each other.
- **Guidance to Producer:** Reassess the relationship and adjust the rating. Negotiate compensation. Production may need to increase to maintain contracted service to known consumers until the hidden consumers are identified and their service terminated.
- **Guidance to Consumer:** If the input is important, negotiate a positive rating from the producer's perspective. Anticipate adverse consequence if the producer decides to block access.

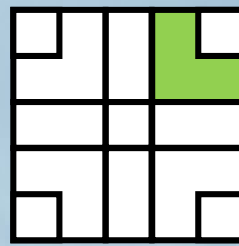


HIDDEN PRODUCER



- **Meaning:** The consumer thinks that it is not using an input from a producer, but the producer is actually delivering the outcome.
- **Implications:** If the input is not needed, costs could be reduced. However, if the input is needed, a hidden producer could adversely affect operations.
- **Guidance to Producer:** Negotiate a positive rating from the consumer's perspective. Anticipate potential adverse implications if the consumer really doesn't need the input.
- **Guidance to Consumer:** Assess how the input is actually being used. Reassess the relationship and adjust the rating.

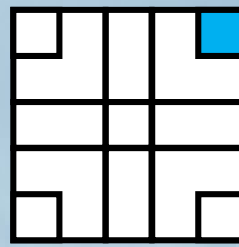




COOPERATIVE

- **Meaning:** The consumer and producer both agree the operational exchange is important.
- **Implications:** It is likely that the consumer will be satisfied with the input received from the producer.
- **Guidance to Producer:** Monitor the relationship for changes over time. Negotiate with the consumer to improve the relationship.
- **Guidance to Consumer:** Monitor the relationship for changes over time. Negotiate with the producer to improve the relationship.

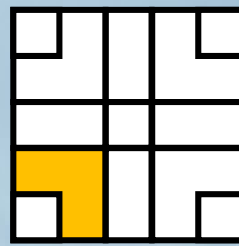




SYMBIOTIC

- **Meaning:** The consumer and producer both agree the operational importance is strong.
- **Implications:** This is a special case of "Cooperative." It is highly likely that the consumer will be satisfied with the input received from the producer.
- **Guidance to Producer:** Monitor the relationship for changes over time.
- **Guidance to Consumer:** Monitor the relationship for changes over time.





ANTAGONISTIC

- **Meaning:** The producer and consumer have identified a negative emergence or adverse implications of the exchange.
- **Implications:** The exchange is unwanted by both systems, potentially adversely affecting operations for both systems.
- **Guidance to Producer:** Renegotiate terms to improve the relationship or seek alternate consumers.
- **Guidance to Consumer:** Renegotiate the relationship or seek alternate Producers and eventually replace the problematic Producer.



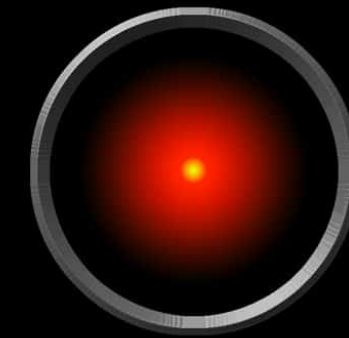
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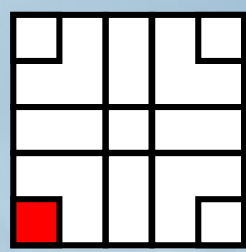
localhost refused to connect.

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ERR_CONNECTION_REFUSED

I'm sorry Dave,
I'm afraid I can't do that.

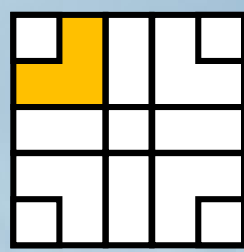




TOXIC

- **Meaning:** The producer and consumer have identified a strong negative emergence or adverse implications of the exchange.
- **Implications:** This is a special case of "Antagonistic." The exchange is highly unwanted by both systems, potentially adversely affecting operations for both systems.
- **Guidance to Producer:** Renegotiate terms to improve the relationship or seek alternate consumers.
- **Guidance to Consumer:** Renegotiate the relationship or seek alternate Producers and eventually replace the problematic producer.

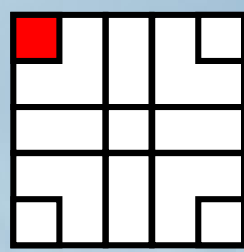




UNWANTED CONSUMER

- **Meaning:** The producer identified a negative emergence or adverse implications for the exchange.
- **Implications:** Unlike the “No Affinity” and “Hidden Consumer” cases, the presence of an unwanted consumer is known.
- **Guidance to Producer:** Explore steps to prevent the unwanted consumer from consuming the outcome.
- **Guidance to Consumer:** Anticipate producer taking steps to block further consumption. Seek alternate producers or negotiate terms to improve the relationship.

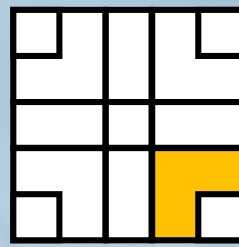




FREELoader

- **Meaning:** The producer identified a negative emergence or adverse implications for the exchange, while the consumer identified it as very important.
- **Implications:** This is a special case of "Unwanted Consumer." A freeloader gets a benefit at the producer's expense.
- **Guidance to Producer:** Prioritize preventing the unwanted consumer from consuming the outcome.
- **Guidance to Consumer:** Anticipate producer taking steps to block further consumption. Seek alternate producers or negotiate terms to improve the relationship.

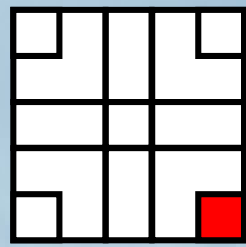




UNWANTED PRODUCER

- **Meaning:** The consumer identified a negative emergence or adverse implications of the exchange.
- **Implications:** Unlike the “No Affinity” and “Hidden Producer” cases, the presence of an unwanted or problematic Producer is known.
- **Guidance to Producer:** Anticipate the consumer blocking further acceptance of producer’s outcomes or switching to an alternate producer. Renegotiate terms to improve the relationship or seek alternate consumers.
- **Guidance to Consumer:** If the producer’s quality of service is not sufficient to meet the consumer’s needs, renegotiate the relationship or explore alternate producers and eventually replace the problematic producer.



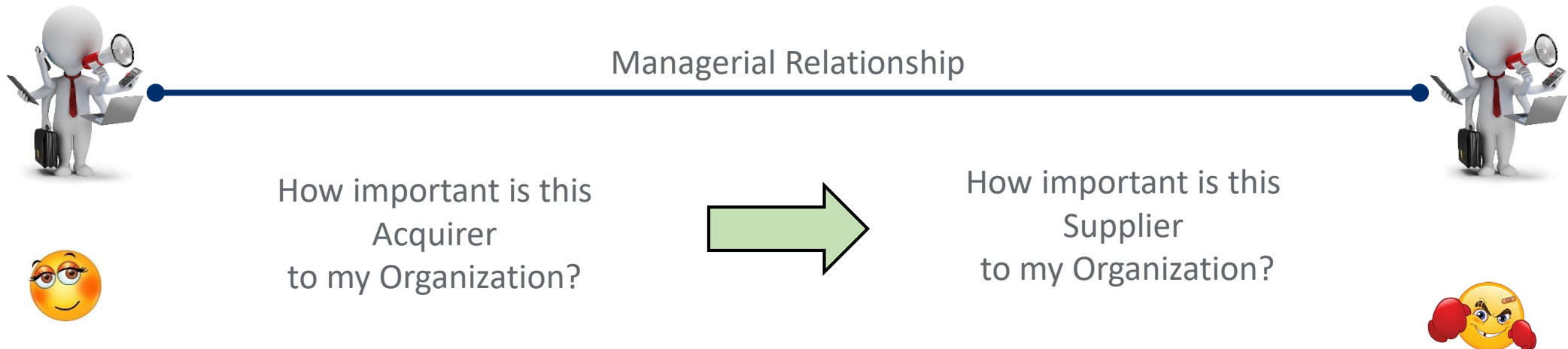


SPAMMER

- **Meaning:** The consumer identified a significant negative emergence or adverse implications of the exchange, while the producer identified it as very important.
- **Implications:** This is a special case of “Unwanted Supplier.” The spammer keeps sending their highly important (to them) outcome that the acquirer really doesn’t want.
- **Guidance to Producer:** Anticipate the consumer blocking further acceptance of producer’s outcomes..
- **Guidance to Consumer:** Reject or replace the problematic input from this producer.

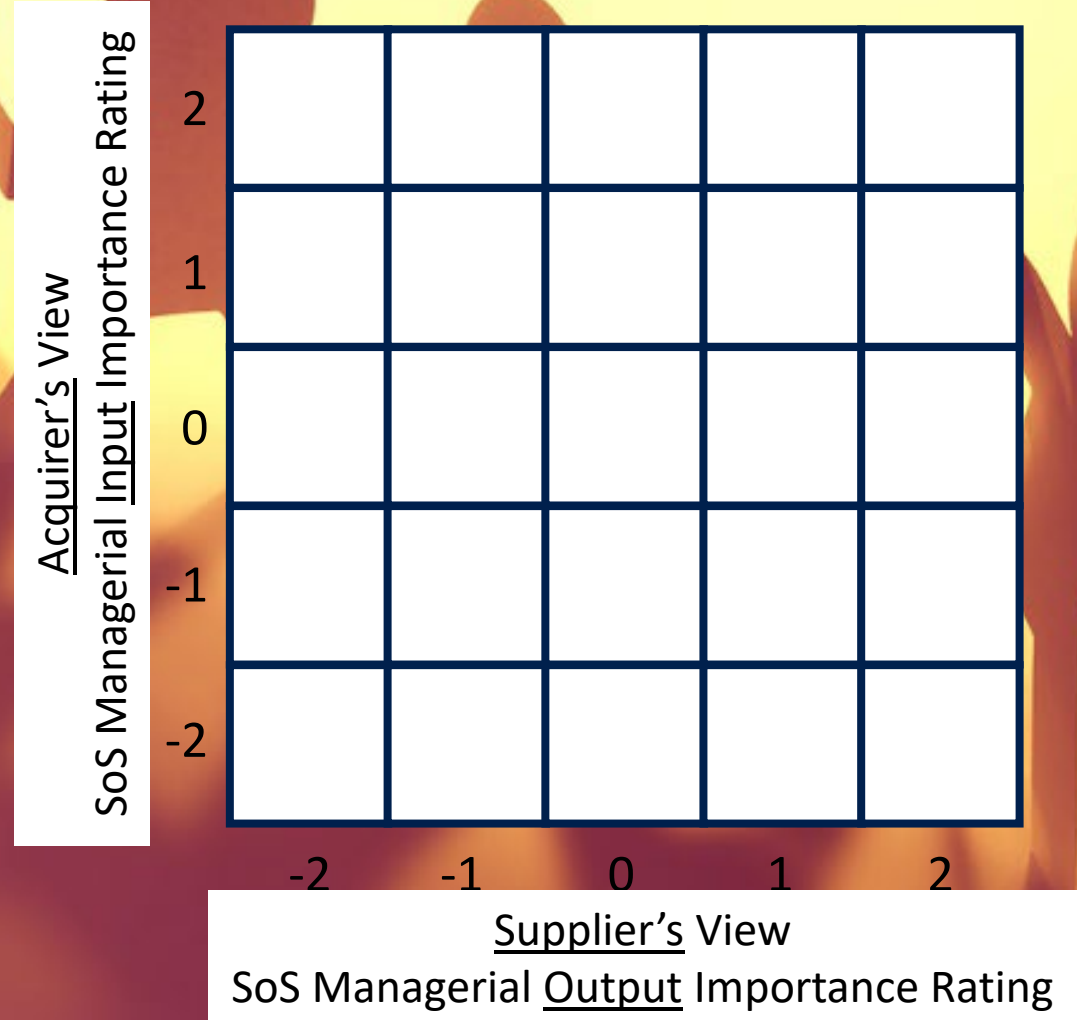


SOS MANAGERIAL AFFINITY



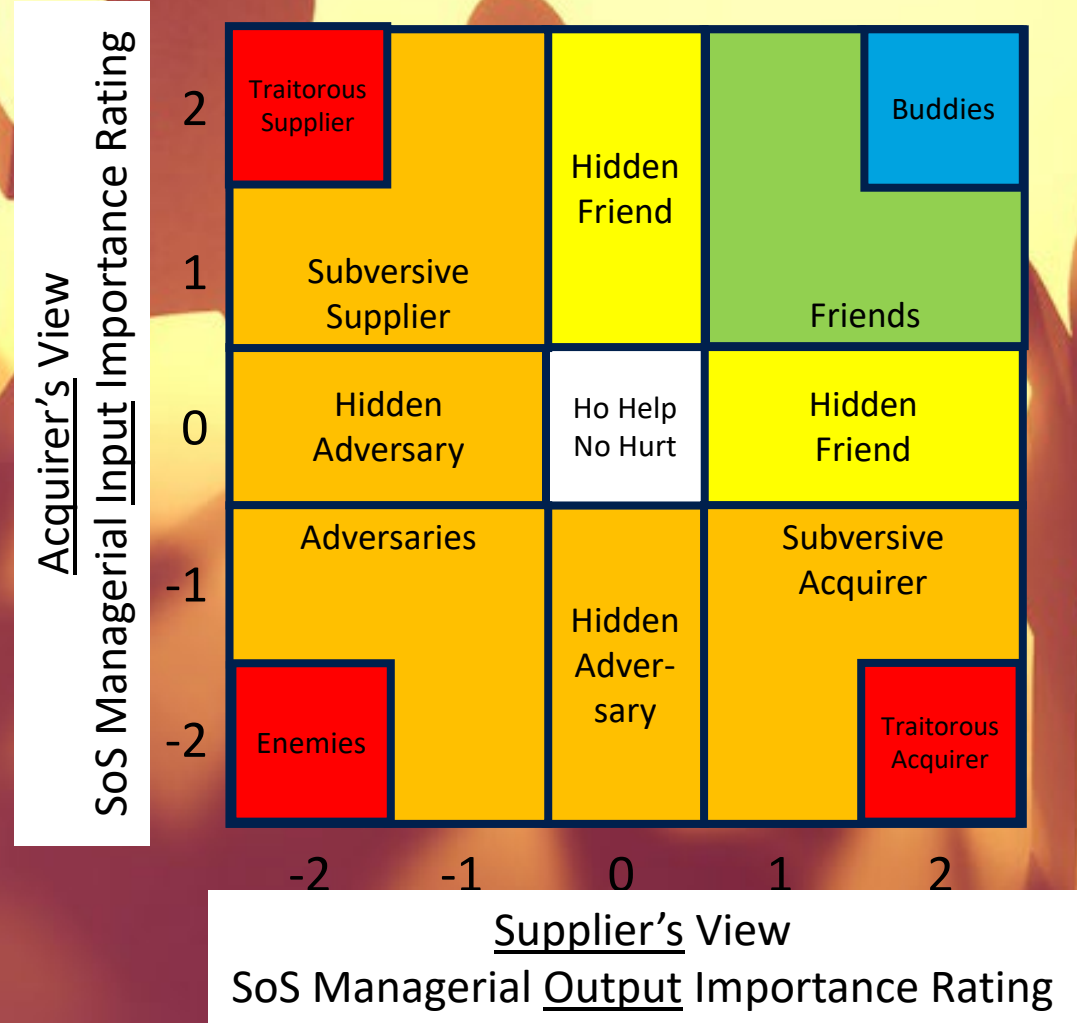
SOS MANAGERIAL AFFINITY

- Map the Acquirer's View to the Supplier's View
- 5 by 5 matrix



SOS MANAGERIAL AFFINITY

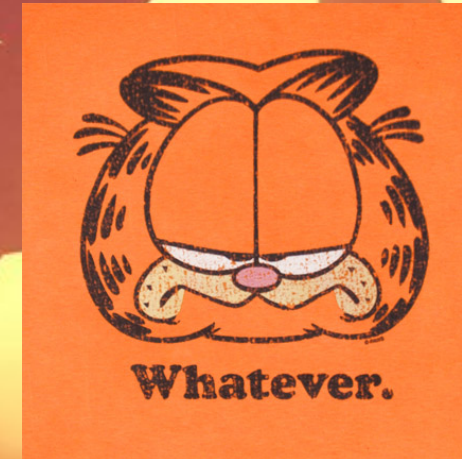
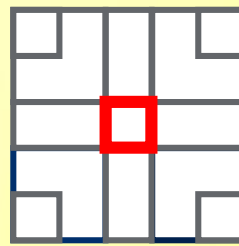
Buddies
Friends
No Help, No Hurt
Hidden Friend
Hidden Adversary
Subversive Supplier
Subversive Acquirer
Adversaries
Traitorous Supplier
Traitorous Acquirer
Enemies

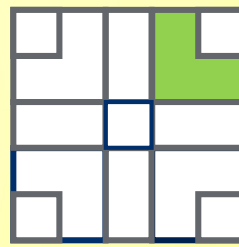


NO HELP, NO HURT

- **Meaning:** Priorities and Incentives in both organizations are not aligned, either positively or negatively.
- **Implications:** The organizations may not help each other because they have no incentive to do so, but they also won't hurt each other because they have no incentive there either.
- **Guidance to Supplier:** Monitor for changes over time.
- **Guidance to Acquirer:** Monitor for changes over time.

SoS Managerial Affinity
No Help, No Hurt

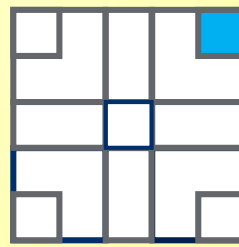




FRIENDS

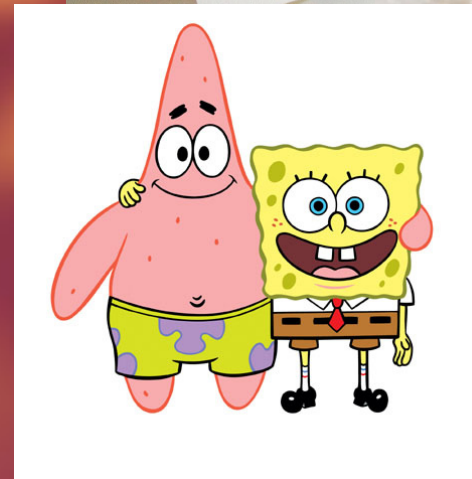
- **Meaning:** Priorities and Incentives in both organizations are somewhat aligned in a positive way.
- **Implications:** The organizations are likely to collaborate fairly effectively. Note that positive alignment can exist without formal agreements.
- **Guidance to Supplier:** Cultivate the relationship. Monitor for changes over time.
- **Guidance to Acquirer:** Cultivate the relationship. Monitor for changes over time.

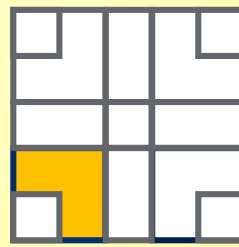




BUDDIES

- **Meaning:** Priorities and Incentives in both organizations are strongly aligned in a positive way.
- **Implications:** This is a special case of "Friends." The organizations are likely to collaborate effectively. Note that strong positive alignment can exist without formal agreements.
- **Guidance to Supplier:** Prioritize and cultivate the relationship. Monitor for changes over time.
- **Guidance to Acquirer:** Prioritize and cultivate the relationship. Monitor for changes over time.

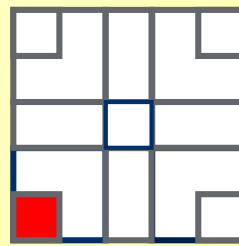




ADVERSARIES

- **Meaning:** Priorities and Incentives in both organizations are aligned, but in a negative way
- **Implications:** The organizations are not likely to collaborate. The relationship between the managers or organizations may be adversarial. The managers or organizations may be undermining each other, threatening the operational outputs of the SoS.
- **Guidance to Supplier:** Reconsider or improve the relationship, not just organizationally but between systems. Seek alternative Acquirers and Consumers.
- **Guidance to Acquirer:** Reconsider or improve the relationship, not just organizationally but between systems. Seek alternative Suppliers and Producers

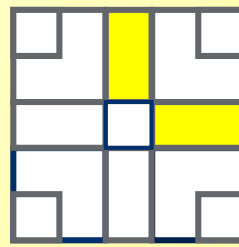




ENEMIES

- **Meaning:** Priorities and Incentives in both organizations are strongly aligned, but in a negative way.
- **Implications:** This is a special case of "Adversaries." The organizations will fight collaboration. The relationship between the managers or organizations may be toxic. The managers or organizations may be actively undermining each other, threatening the operational outcomes of the SoS.
- **Guidance to Supplier:** Terminate the relationship, not just organizationally but between systems. Seek alternative Acquirers and Consumers.
- **Guidance to Acquirer:** Terminate the relationship, not just organizationally but between systems. Seek alternative Suppliers and Producers.

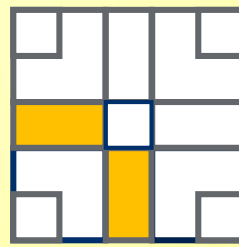




HIDDEN FRIEND

- **Meaning:** One side didn't care about the other, who really is a friend.
- **Implications:** This relationship is potentially beneficial, representing a lost opportunity. Cultivating the relationship could reduce risk to operations.
- **Guidance to Supplier:** Cultivate the relationship and consider adjusting to the friendly ground.
- **Guidance to Acquirer:** Cultivate the relationship and consider adjusting to the friendly ground.





HIDDEN ADVERSARY

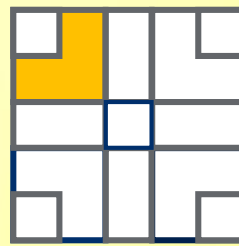
- **Meaning:** One side didn't care about the other, who really is an adversary.
- **Implications:** This relationship is potentially dangerous. A hidden adversary is a risk to operations.
- **Guidance to Supplier:** Reassess the relationship and consider improving or adjusting to the common ground if possible. If not, plan to terminate the relationship.
- **Guidance to Acquirer:** Reassess the relationship and consider improving or adjusting to the common ground if possible. If not, plan to terminate the relationship.



SUBVERSIVE SUPPLIER

- **Meaning:** The acquirer thinks the supplier's priorities and incentives are aligned in a positive way, but they really are aligned in a negative way.
- **Implications:** This relationship is dangerous. A subversive supplier is a risk to acquirer's operations.
- **Guidance to Supplier:** Reassess the subversive aspects of the relationship and consider ways to improve it if possible.
- **Guidance to Acquirer:** Reassess the subversive aspects of relationship and consider ways to improve it if possible.

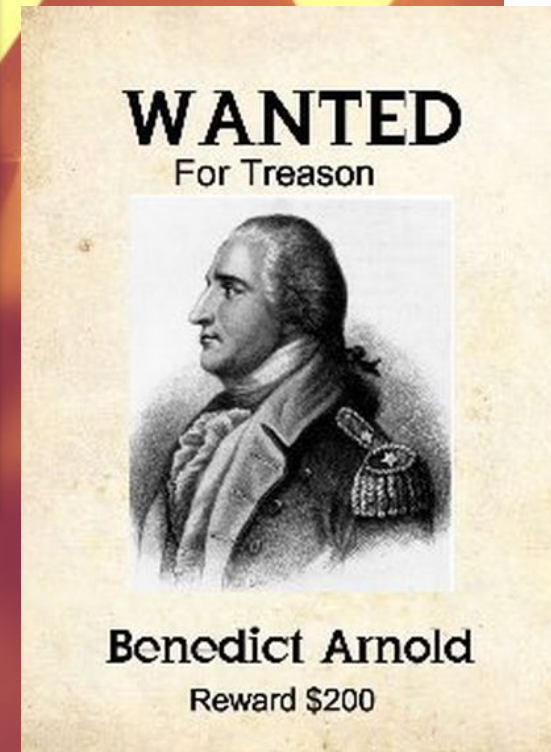
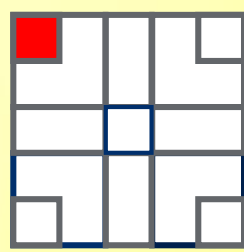
SoS Managerial Affinity
Subversive Supplier



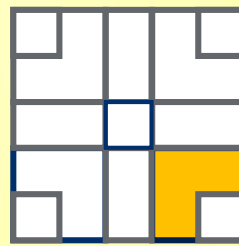
TRAITOROUS SUPPLIER

- **Meaning:** The acquirer thinks the supplier's priorities and incentives are strongly aligned in a positive way, but they really are strongly aligned in a negative way..
- **Implications:** This is a special case of "Subversive Supplier." This relationship is very dangerous. A traitorous supplier is a high risk to the acquirer's operations.
- **Guidance to Supplier:** Anticipate being replaced as soon as the acquirer finds an alternative.
- **Guidance to Acquirer:** Terminate the relationship and replace the supplier immediately.

SoS Managerial Affinity
Traitorous Supplier

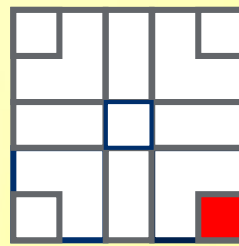


SUBVERSIVE ACQUIRER



- **Meaning:** The supplier thinks the acquirer's priorities and incentives are aligned in a positive way, but they really are aligned in a negative way.
- **Implications:** This relationship is dangerous. A subversive supplier is a risk to the supplier's operations.
- **Guidance to Supplier:** Reassess the subversive aspects relationship and consider ways to improve it if possible.
- **Guidance to Acquirer:** Reassess the subversive aspects relationship and consider ways to improve it if possible.





TRAITOROUS ACQUIRER

- **Meaning:** The supplier thinks the acquirer's priorities and incentives are strongly aligned in a positive way, but they really are strongly aligned in a negative way.
- **Implications:** This is a special case of "Subversive Acquirer." This relationship is dangerous. A traitorous acquirer is a high risk to the supplier's operations.
- **Guidance to Supplier:** Anticipate being replaced as soon as the acquirer finds an alternative.
- **Guidance to Acquirer:** Terminate the relationship and replace the supplier immediately.



SUMMARY



AND ADDITIONAL OBSERVATIONS

SUMMARY



SoS Operational Affinity

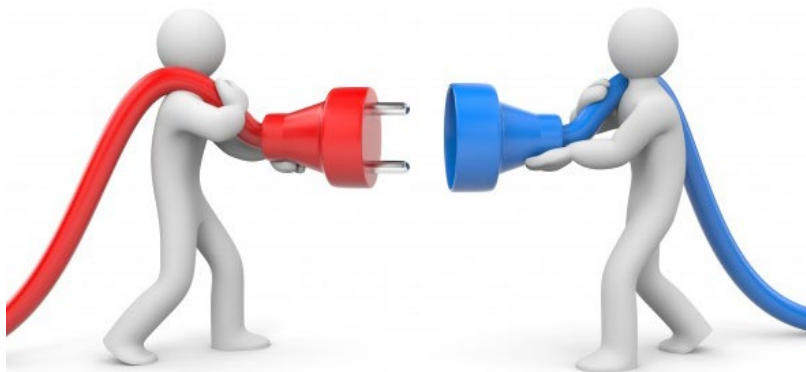
- Assess the importance of a system-to-system exchange from both sides
 - SoS Input Importance Rating
 - SoS Output Importance Rating
- Define the relationship
 - SoS Operational Affinity
 - Meaning
 - Implications
- Take Action
 - Guidance for Producer
 - Guidance for Consumer

SoS Managerial Affinity

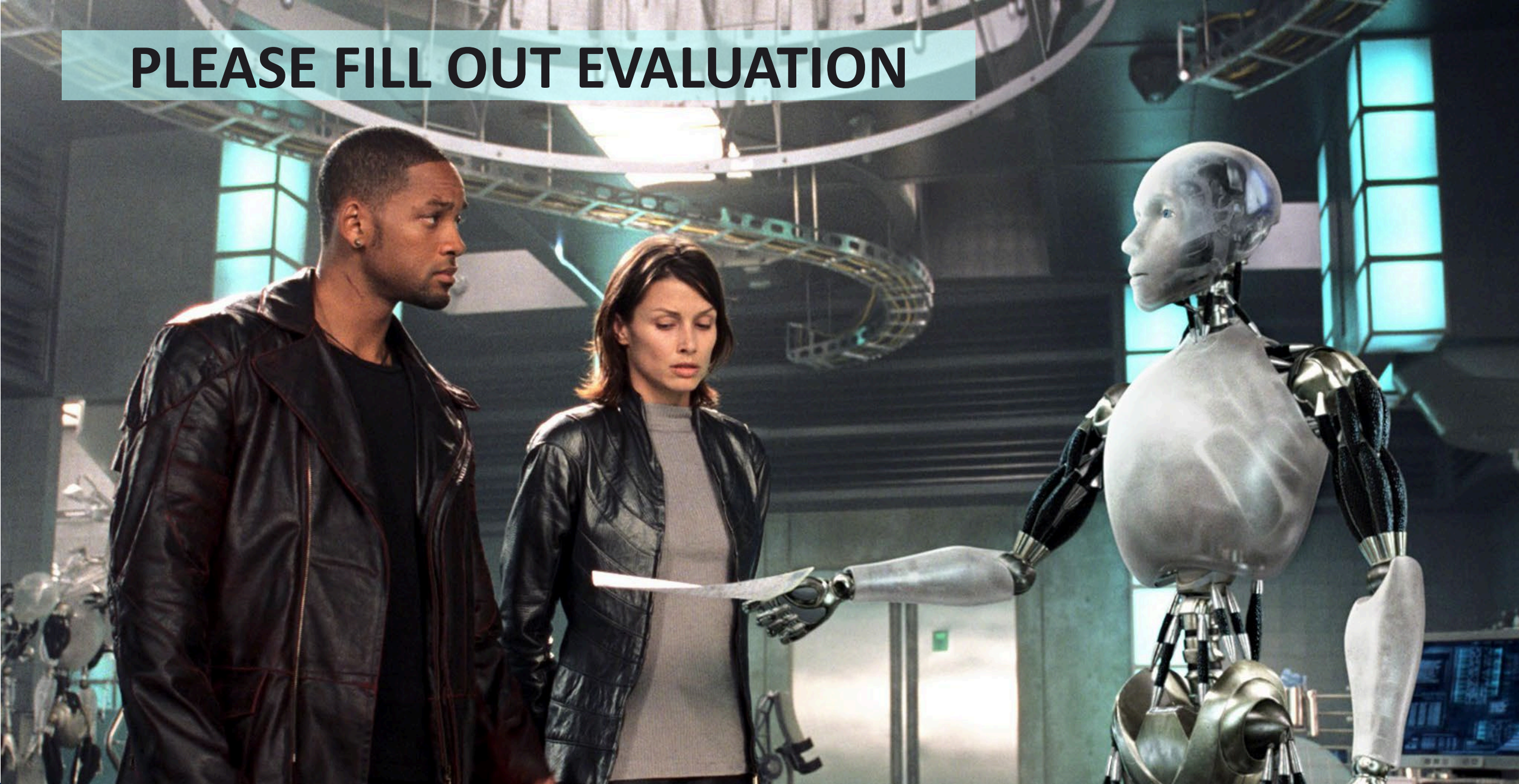
- Assess the importance of an organization-to-organization exchange from both sides
 - SoS Acquirer Alignment Rating
 - SoS Supplier Alignment Rating
- Define the relationship
 - SoS Managerial Affinity
 - Meaning
 - Implications
- Take Action
 - Guidance for Supplier
 - Guidance for Acquirer

MONDAY MORNING ACTION PLAN

- Consider the people around you
 - And the systems they're responsible for
- Assess and improve the relationships
 - Between people/orgs (managerial affinity)
 - Between systems (operational affinity)
 - Send Mike better names and pictures (please)



PLEASE FILL OUT EVALUATION





QUESTIONS

ADDITIONAL OBSERVATIONS

- Affinities along the diagonal of the affinity matrixes (-2=-2, 0=0, etc) reflect known alignment of perspectives. These relationships represent known risks to operations.
- Affinities off the diagonal reflect misunderstandings regarding the alignment. These relationships represent unknown risks to operations. The greater the distance from the diagonal, the greater the risk.
- Assessing relationships provides an opportunity to make improvements or mitigate risks, but the even attempting to make the assessment introduces other risks. A “Traitorous Supplier” may not like being labeled as such, even if true.
- SoS Operational Affinity appears to align well to technical perspectives that likely resonate with systems engineers. SoS Managerial Affinity appears to be more socio-political, something systems engineers may struggle with or actively avoid.

MORE ADDITIONAL OBSERVATIONS

- Maier's taxonomy (directed, collaborative, virtual) [1] or Dahmann and Baldwin's taxonomy (directed, collaborative, acknowledged, virtual) [3] could map to any of the SoS Operational Affinity cells or the SoS Managerial Affinity cells. Within a Directed SoS, for example, any of the SoS Affinities could appear.
- Multiple SoS Operational Affinities may appear within the same SoS.
- Multiple SoS Managerial Affinities may appear within the same SoS.
- A SoS exists when systems are independent and interdependent. When systems are interdependent, their owning organizations are also interdependent, whether they realized it or not.
- Organizations can be independent and interdependent without creating an SoS.
- The affinities have a longitudinal dimension as the SoS evolves over time.
- The affinities may be useful in mitigating risks related to constituent systems joining or leaving an SoS as it evolves.

REFERENCES

- [1] Maier, M. W., “Architecting Principles for Systems-of-Systems,” *Systems Engineering*, Vol 1: 267-284, 1998
- [2] ISO/IEC/IEEE 15288, Systems and software engineering - System life cycle processes
- [3] Dahmann J. and Baldwin K., Understanding the current state of US Defense systems of systems and the implications for systems engineering, *IEEE International Systems Conference*, 2008
- [4] Yokell, Mike R, “Systems of Systems Managerial and Operational Affinity – Assessing and Improving Relationships Within Systems of Systems”, *Lockheed Martin Journal of Systems Engineering and Architecture*, Volume 3, No. 1, Spring 2018.

BIOGRAPHY



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Dr. Mike Yokell is a Lockheed Martin Fellow and Deputy Director, Systems Engineering. He is the US representative to International Standards setting bodies for Systems and Software Engineering and is the project editor for two new international standards on Systems of Systems Engineering. Mike is certified as an expert systems engineering professional by the International Council on Systems Engineering (INCOSE). He holds multiple US and European Patents for Model Based Systems Engineering (MBSE) and large scale immersive virtual reality.

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Today's Presentation

Things to think about

- How can this be applied in your work environment?
- What did you hear that will influence your thinking?
- What is your take away from this presentation?



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