FuSE
Future of Systems Engineering

FuSE: Methodologies Themes to Disrupters

Sunday 29 Jan 2023, 8:00-10:00 PST

Chris Hoffman
FuSE Methodologies Lead

Purpose / Reason Why & Desired Outcome:

- Diverse categories of disrupters are captured
- Participants have fully exhausted disrupters from their perspectives
- Duplicates are grouped
- Disrupters are prioritized (top 3)

Nice to Have:

- Disrupters that are 'noise factors' are identified
- Disrupters are tagged that are within our ability to change (accept, transfer, mitigate, ...)
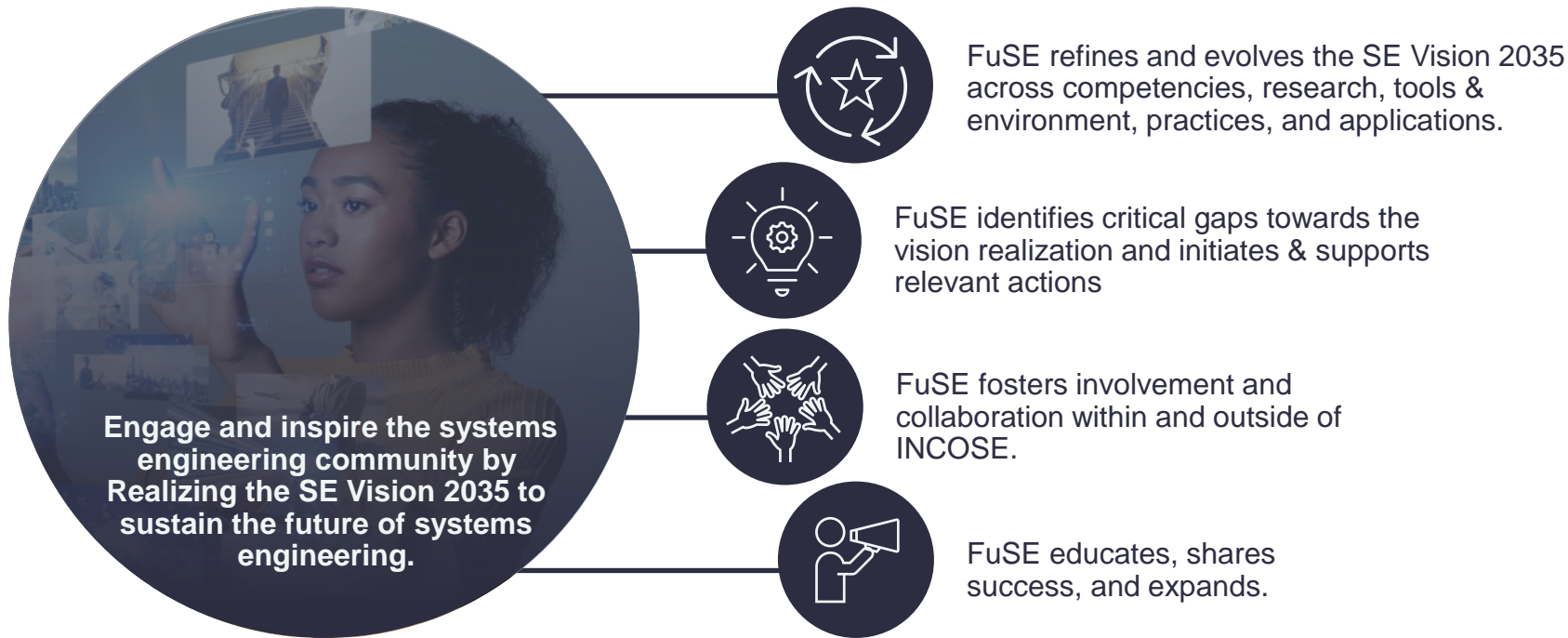
Agenda.
8:00 – 10:00 h

- All: Introduction (20 min)

- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions

- All: Report-out (30 min)

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FuSE Program Mission Statement

Engage and inspire the systems engineering community by Realizing the SE Vision 2035 to sustain the future of systems engineering.

FuSE refines and evolves the SE Vision 2035 across competencies, research, tools & environment, practices, and applications.

FuSE identifies critical gaps towards the vision realization and initiates & supports relevant actions

FuSE fosters involvement and collaboration within and outside of INCOSE.

FuSE educates, shares success, and expands.

FuSE Program Charter

☀ Vision Statement

Inspire the global community to realize the Vision of SE

▦ Mission

Engage and inspire the systems community for sustaining the future of systems engineering in realizing the SE Vision 2035

FuSE **refines and evolves the SE Vision 2035** across competencies, research, tools & environment, practices, and applications.

FuSE **identifies critical gaps** towards the vision realizations and **initiates & supports relevant actions**

FuSE **fosters involvement and collaboration** within and outside of INCOSE.

FuSE **educates, shares success, and expands**.

🏆 Success Factors

Inclusive: From an exclusive club to inclusive initiative

Attractive: Engage members and non-members

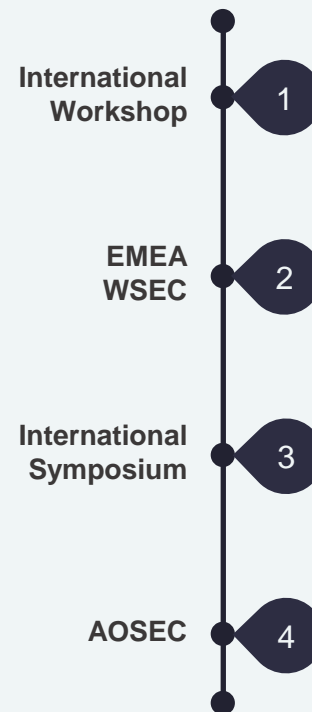**Implementation:** The degree to which the road map is realized

Fresh: Relevant and updated road map and context

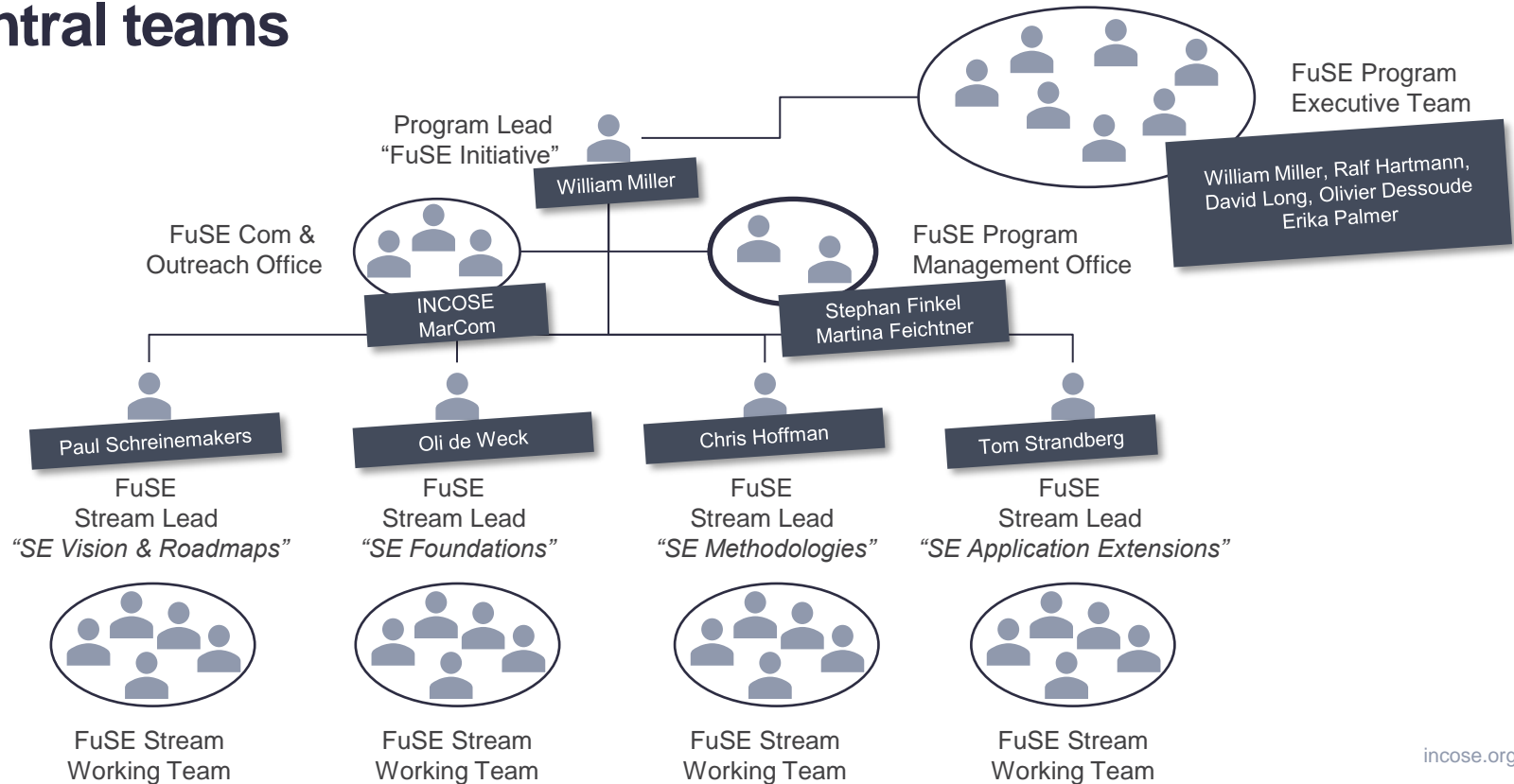**Close to application:** Involvement of companies and domains

Global promotion: Attractive global digital marketing

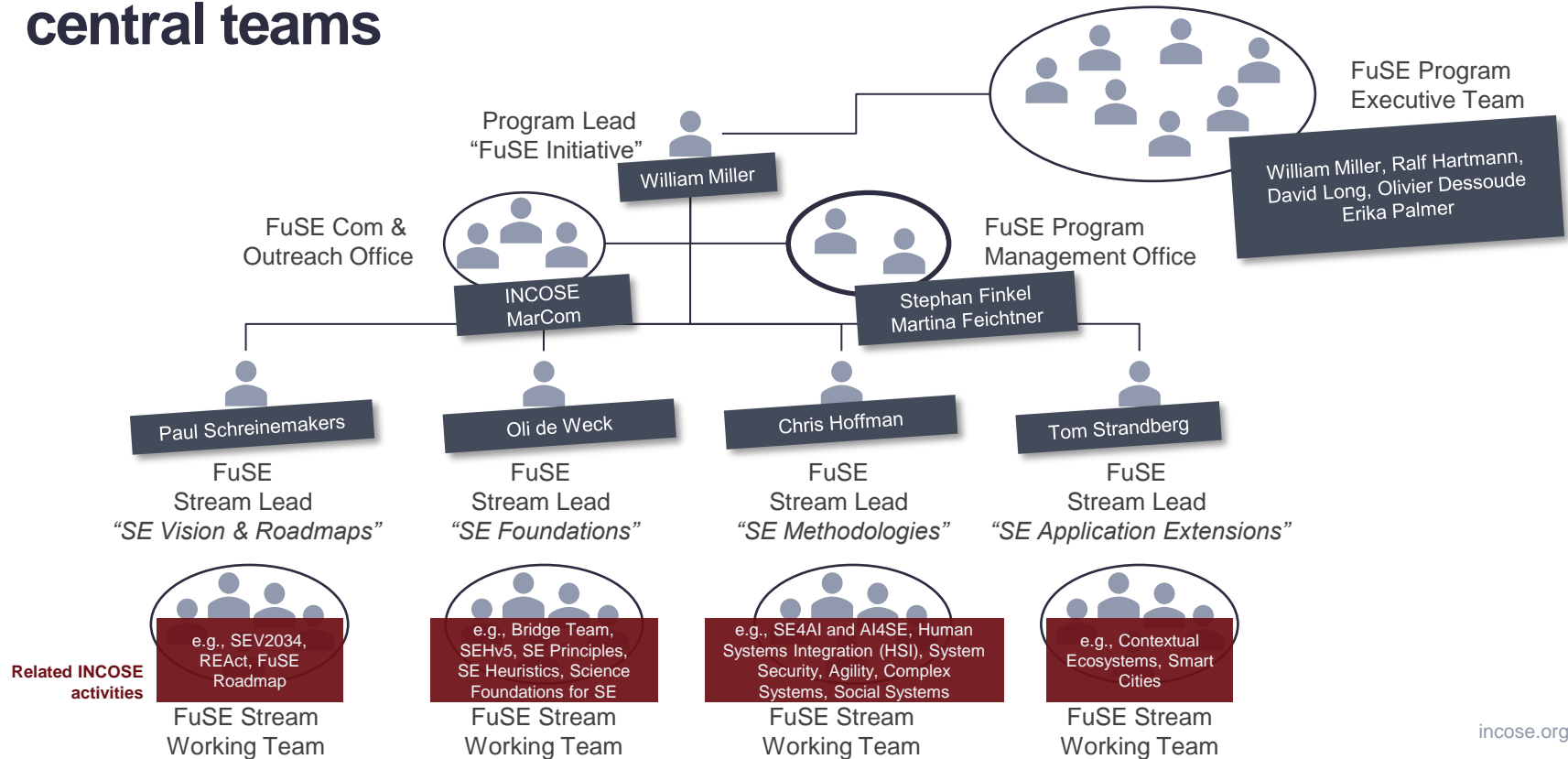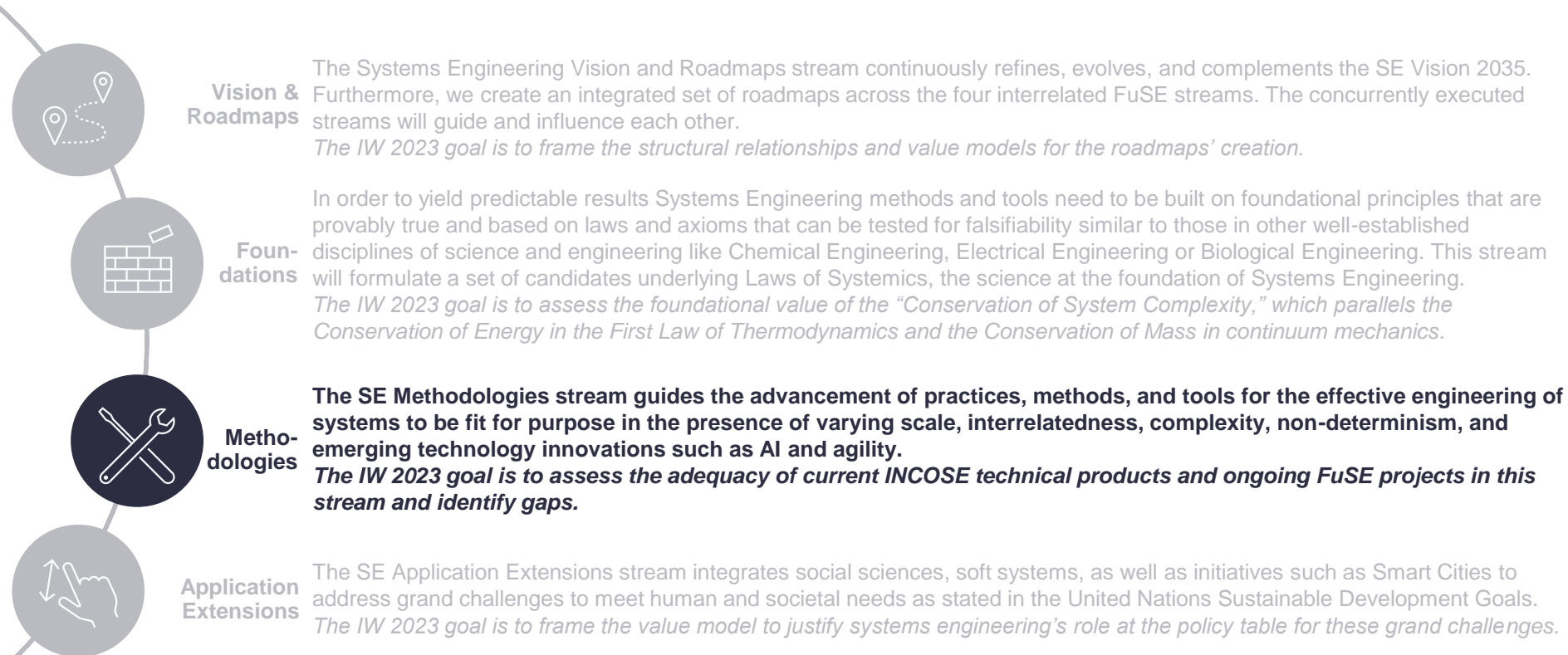**Passion:** To get the working group proud to be part of it

⚑ 2023 Milestones

- International Workshop — 1
- EMEA WSEC — 2
- International Symposium — 3
- AOSEC — 4

The FuSE program is organized in 4 streams with additional central teams

Program Lead
"FuSE Initiative"

William Miller

FuSE Program
Executive Team

William Miller, Ralf Hartmann,
David Long, Olivier Dessoude
Erika Palmer

FuSE Com &
Outreach Office

INCOSE
MarCom

FuSE Program
Management Office

Stephan Finkel
Martina Feichtner

Paul Schreinemakers

FuSE
Stream Lead
"SE Vision & Roadmaps"

Oli de Weck

FuSE
Stream Lead
"SE Foundations"

Chris Hoffman

FuSE
Stream Lead
"SE Methodologies"

Tom Strandberg

FuSE
Stream Lead
"SE Application Extensions"

FuSE Stream
Working Team

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**Related INCOSE
activities**

e.g., SEV2034,
REAct, FuSE
Roadmap

FuSE Stream
Working Team

e.g., Bridge Team,
SEHv5, SE Principles,
SE Heuristics, Science
Foundations for SE

FuSE Stream
Working Team

e.g., SE4AI and AI4SE, Human
Systems Integration (HSI), System
Security, Agility, Complex
Systems, Social Systems

FuSE Stream
Working Team

e.g., Contextual
Ecosystems, Smart
Cities

FuSE Stream
Working Team

The FuSE program is organized in 4 streams

Vision & Roadmaps
The Systems Engineering Vision and Roadmaps stream continuously refines, evolves, and complements the SE Vision 2035. Furthermore, we create an integrated set of roadmaps across the four interrelated FuSE streams. The concurrently executed streams will guide and influence each other.
The IW 2023 goal is to frame the structural relationships and value models for the roadmaps' creation.

Foun-dations
In order to yield predictable results Systems Engineering methods and tools need to be built on foundational principles that are provably true and based on laws and axioms that can be tested for falsifiability similar to those in other well-established disciplines of science and engineering like Chemical Engineering, Electrical Engineering or Biological Engineering. This stream will formulate a set of candidates underlying Laws of Systemics, the science at the foundation of Systems Engineering.
The IW 2023 goal is to assess the foundational value of the "Conservation of System Complexity," which parallels the Conservation of Energy in the First Law of Thermodynamics and the Conservation of Mass in continuum mechanics.

Metho-dologies
The SE Methodologies stream guides the advancement of practices, methods, and tools for the effective engineering of systems to be fit for purpose in the presence of varying scale, interrelatedness, complexity, non-determinism, and emerging technology innovations such as AI and agility.
The IW 2023 goal is to assess the adequacy of current INCOSE technical products and ongoing FuSE projects in this stream and identify gaps.

Application Extensions
The SE Application Extensions stream integrates social sciences, soft systems, as well as initiatives such as Smart Cities to address grand challenges to meet human and societal needs as stated in the United Nations Sustainable Development Goals.
The IW 2023 goal is to frame the value model to justify systems engineering's role at the policy table for these grand challenges.

7 success factors the FuSE program

Attractive

Engage members and non-members

Inclusive

From an exclusive club to inclusive initiative

Close to application

Involvement of companies and domains

Fresh

Relevant and updated road map and context

Passion

To get the working group proud to be part of it

Implementation

The degree to which the road map is realized

Global promotion

Attractive global digital marketing

FuSE Methodologies Stream
Partial Baseline

Products (various stages):
- DE Measurement Framework,
- SE Principles,
- Model Portfolio Management Guide,
- Digital Systems Engineering Process Model,
- Human Systems Integration Reference,
- Agile SE Decision Guidance Method,
- SE-AI Primer,
- SE Handbook 5th Edition

Related working groups & initiatives (partial list):
- Agile Systems and Systems Engineering
- Artificial Intelligence Systems
- Competency
- Complex Systems
- Configuration management
- Digital Engineering Information Exchange
- Enterprise Systems
- Integration, Verification & Validation
- Knowledge Management
- Lean Systems Engineering
- MBSE Initiative
- MBSE Patterns
- NAFEMS-INCOSE Systems Modelling & Simulation
- Product Line Engineering
- Professional Competencies & Soft Skills
- SE Tools Database
- Small Business Systems Engineering
- Social Systems
- System of Systems
- Systems and Software Interface
- Systems Security Engineering
- Tools Integration & Model Lifecycle Management
- Value Proposition Initiative
- SE Handbook Team

Discussions > Activities > Presentations > Panels > Papers > Periodicals > Products > Practices > Standards

Key Insights of SAT FuSE Sessions

Vision & Roadmaps

Session Topic:
Introduction, Activities for 2023, Prioritization of roadmap topics to be addressed

Key Insight:
The highest priority for the Vision & Roadmaps stream is to **make the roadmap goals measurable.**
The **reason-why** behind the goals needs to be clear.
Soft skills and outreach will play an important part in the Future of Systems Engineering and needs to be fostered in the vision.

Foundations

Session Topic:
Frame SE Foundations in terms of First Law
Conducted complexity experiment to collect data

Key Insight:
INCOSE members were highly engaged (40+20=~60)
Generated about 300 data points to be post-analyzed
Valuable feedback received for making "SE" Experiments more realistic (e.g. introduce unexpected nodes in the system, show value of MBSE human augmentation)

Methodologies

Session Topic:
Introduction, Activities for 2023, Initial feedback, Opt-in participation

Key Insight:
What does INCOSE want to be in terms of methodology.
If INCOSE wants to be more prescriptive about the how – are we ready to take the leap?

Application Extensions

Session Topic:
Introduction, Feedback on Stream scope and planned Activities

Key Insight:
Small group, a lot of energy and useful output, including:
Extending the application of SE into new domains requires a clear and simple message tailored to domain;
We also need to conduct joint activites with external organizations creditable in the domain to prove the value SE.

Systems Engineering Methodologies Stream

Chris Hoffman
 Stream Lead "SE Methodologies"

e christopher.hoffman@incose.net

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The IW 2023 goal is to assess the adequacy of current INCOSE technical products and ongoing FuSE projects in this stream and identify gaps.

	SAT	SUN	MON	TUE
08:00		Elaborate disruptors:	Clarify problems / opportunities:	
08:30		1. Scale & Interrelatedness	1. Digital ecosystem	Wrap-up FuSE (for participants)
09:00		2. Complexity, Chaotic, Complicated, Clear	2. Software as the capability driver	
09:30	Break	3. A.I. for SE, other technologies	3. Continuous iterative model development	
10:00	FuSE Kick-off	4. TBD by participants	4. Evolution in learning systems	Break
10:30				
11:00				Wrap-up FuSE
11:30				
12:00	Lunch			
12:30				
13:00				
13:30				
14:00	Introduction, Activities for 2023, Initial feedback, Opt-in participation			
14:30		Break		
15:00	Break			
15:30	Introduction, Activities for 2023, Initial feedback, Opt-in participation			
16:00				
16:30				

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Nice to Have:

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What is the KJ Method?

The KJ-Method or KJ Technique, is an idea generating and prioritizing technique named after its inventor, Jiro Kawakita. This technique is one of the most popular brainstorming variations for design, team, retrospective, and project meetings. The KJ Technique includes these steps:

- **Individual brainstorming:**
  Everyone silently writes down ideas. Each idea goes on a separate note.

- **Sharing ideas:**
  People take turns sharing the ideas they've written and posting them to the group space.

- **Grouping or Clustering:**
  Working together, the team makes groups of similar ideas or concepts. Each group then gets named with a single word or short phrase that best captures the core concept underlying the ideas in that group.

- **Voting:**
  The team then votes on which concepts matter most. Each person gets a set number of votes (or "dots") that they can place on the concepts they care most about. The concepts that get the most dots win.

A 20,000-foot Look at the KJ Method

1. Agree on theme

2. Write an understand facts

3. Group similar facts

4. Title the groups
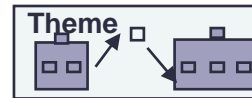
5. Lay out groups and show relations between groups

6. Vote on most important second-level issues and draw conclusions

Quickly split into groups and find an area.
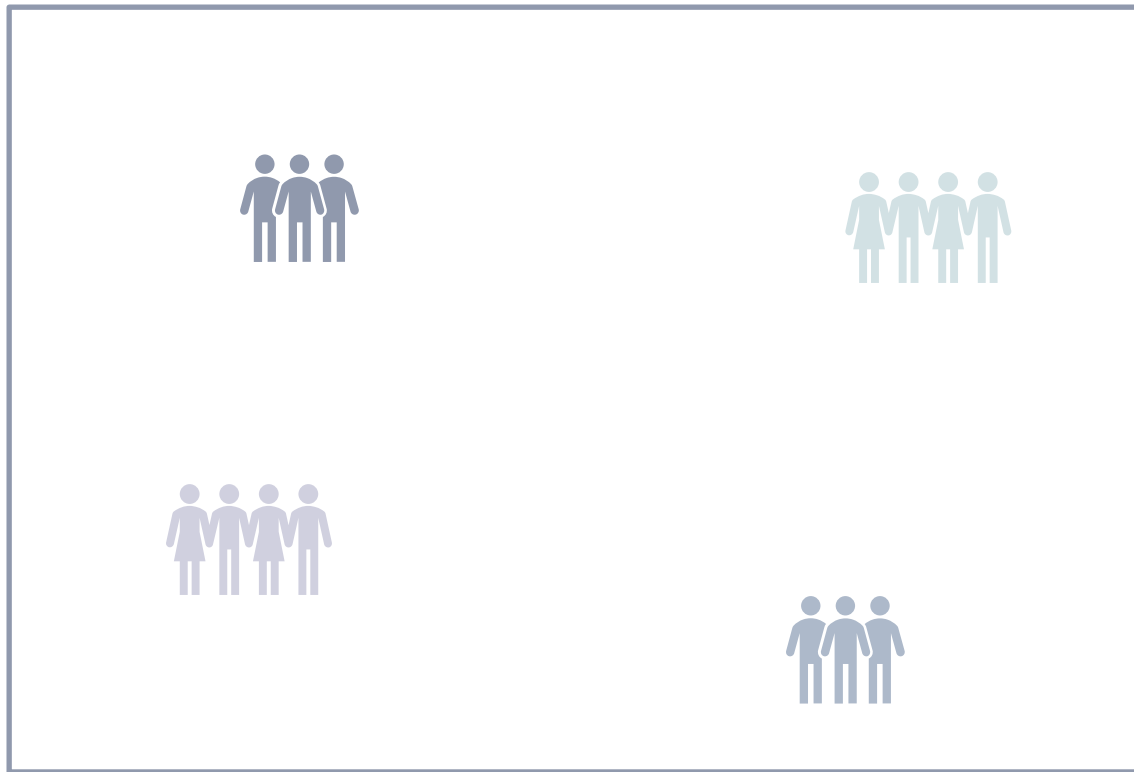
Resources needed (per group)
- 3 Flipchart papers
- 5 pads of 3x3 sticky notes
- 2 pads of 3x5 sticky notes
- 10 med point black markers
- 4 med point red markers
- 2 med point blue markers
- 2 large black markers
- 2 large red markers
- 2 large green markers
- 2 large blue markers
- Colored dot stickers
- ¾" Masking Tape
- Functioning Brains
- Vertical surface for hanging flipcharts

Write theme

5 min to understand and write the theme.

Themes (1 per group, variations are OK)

1. What is preventing the advancement of practices/methods/tools in the presence of **varying scale and interrelatedness**?

2. What is preventing the advancement of practices/methods/tools for systems that are **complex, chaotic, complicated, clear**?

3. What is preventing the advancement of practices/methods/tools in the presence of **new technologies (e.g., AI, digital ecosystems, …)**

4. **What are obstacles** in advancing practices/methods/tools?

5. What are practice/method/tool **disrupters**?

6. What is preventing us from…?

References: SE Vision 2035, WG plans, company input…

Theme

State the Theme
Block print in 1" black in the upper left corner of a large sheet (2-3 flip chart papers together).

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - **Agree on theme statement (5 min)**
  - Write and understand the facts
  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions
- All: Report-out (30 min)

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Gather Facts

10 mins to **silently** gather facts

Definition:
"Voice, fact, image"

an individual thought, idea, image or statement that is to be considered and can stand on its own merits.

Hints for completing the notes:

- Address Theme
- One Idea
- Complete Sentences
- Lower Level, Specific
- Big Block Printing
- Limited to four (4) lines
- Multi-valued, NOT Two-Valued
- Sticky Side on Top

References: SE Vision 2035, WG plans, company input…

Theme

Gather Facts
- Bold black pen
- Block printing
- One fact per note
- Initials in lower left corner, seq. # (fact source)

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - **Write and understand the facts (10 + 10 min)**
  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions
- All: Report-out (30 min)

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Understand

10 mins to **understand** the facts

Assemble the data:
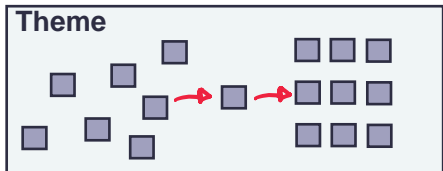
Hints for completing the notes:

- Remove any exact duplicates
- If necessary, reduce to 20-30 notes
- Use a dot exercise (red pen) to mark survivors (pick the most impactful notes). Repeat as needed to reduce.
- Team should be alert, active listeners as each note is read and advocated.

References: SE Vision 2035, WG plans, company input…

Understand Facts
- Read aloud & understand each note as a group
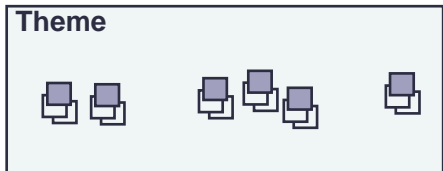- Check wording, light editing if needed
- Use parking lot for out-of-scope notes

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - **Write and understand the facts (**10 + **10 min)**
  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
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First Grouping

5 min to **silently group** the facts

Group the facts:

- In silence (levels the influence)
- Group by full intention and meaning of each note, not by similar words.
- If a note keeps moving among groups, break silence and discuss reasons. Consider making a new group

Theme

Group Facts
- **Silence**
- Group intuitively, not logically
- No more than 3 per group
  Lone wolves (ungrouped facts) are OK
  You may move grouped facts if you disagree

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - **Group similar facts (5 min)**
  - Title the groups
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions
- All: Report-out (30 min)

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References: SE Vision 2035, WG plans, company input…

Title Groups

10 min to **title** the groups

Title the groups:

- Combination of facts using conjunctions (e.g. and, or, if) is not allowed in a title
- When you are done, each black note should be an equally good example of the fact described in the red note title (the "is a" relationship)

Theme

Title Groups
- RED bold pen
- A complete sentence that still answers the theme question
- Abstract UP one level, in a fair and equal manner
- Check your work

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - **Title the groups (10 min)**
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions
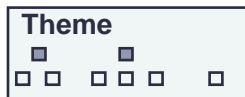- All: Report-out (30 min)

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Second Grouping

5 min to **group** 2nd levels

Assemble the data:

Theme

Hints for completing the notes:

- In silence (levels the influence)
- Group by full intention and meaning of each note, not by similar words.
- If a note keeps moving among groups, break silence and discuss reasons. Consider making a new group
- Be quick – you should have a good understanding of the content by now!

References: SE Vision 2035, WG plans, company input…

Theme

Nest the groups
Pull black notes in each group under their red titles

2nd Level Groups
Group RED (title) notes and any lone wolves using same rules as earlier for black (fact) notes

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - Title the groups
  - **Lay out groups and show relations between groups (5 + 5 + 5 min)**
  - Vote on most important second-level issues and draw conclusions
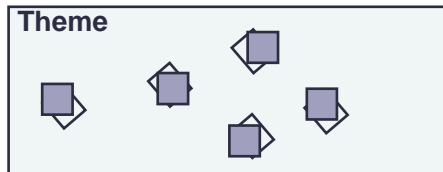- All: Report-out (30 min)

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Title 2nd Groups

5 min to **title** the groups

Title the groups:

- Combination of facts using conjunctions (e.g. and, or, if) is not allowed in a title
- When you are done, each black note should be an equally good example of the fact described in the red note title (the "is a" relationship)

Theme

Title Groups
- BLUE bold pen
- A complete sentence that still answers the theme question
- Abstract UP one level, in a fair and equal manner
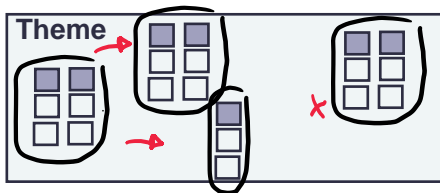- Check your work

- All: Introduction (20 min)

- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - Title the groups (10 min)
  - **Lay out groups and show relations between groups (**5 + **5** + 5 **min)**
  - Vote on most important second-level issues and draw conclusions

- All: Report-out (30 min)

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Show relations

5 min to **nest & show** relations

Nest the 2nd level groups:
When nesting, turn lone wolves 45° so they may be separated when these groups are expanded later

Show relations:

References: SE Vision 2035, WG plans, company input…
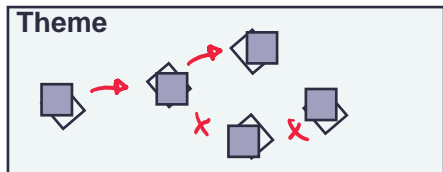
Nest the groups
Pull red and black notes in each group under their blue titles

Show Relations
- RED arrow symbol (one way) for Cause-and-Effect relationships
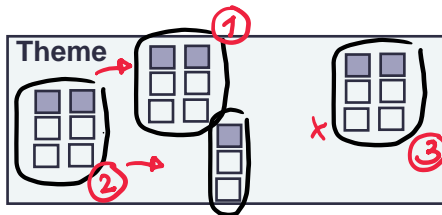- RED "X" symbol for competing or ambiguous relationships

- All: Introduction (20 min)

- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - Title the groups
  - **Lay out groups and show relations between groups (**5 + 5 + **5 min)**
  - Vote on most important second-level issues and draw conclusions

- All: Report-out (30 min)

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Expand Layout

5 min to **complete** the layout

Expand Layout:

- Follow the color rules for outlining. The common patterns are helpful for graphical communications
- Tell a story, left to right.
- If you have time, Block print (in ALL CAPS) the blue titles on the sheet

References: SE Vision 2035, WG plans, company input…

Complete layout
- Open-up the groups on the sheet
- Outline red groups with black line
- Outline blue groups with green line
- Draw red arrow and X symbols on the sheet
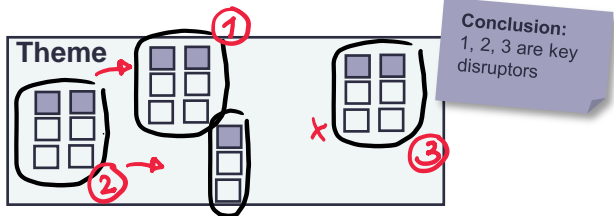- Save a space at upper right for a conclusion statement

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  - **Vote on most important second-level issues and draw conclusions (5 + 5 + 5 min)**
- All: Report-out (30 min)

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Priority Vote

5 min to **vote** on priority

Vote at Red or Lone Wolf Level:

Hints:
- Use dot stickers for votes.
- Write the point value [3, 2, or 1] on the dot.
- Pattern the top 3 areas by priority

Top	2ⁿᵈ	3ʳᵈ

References: SE Vision 2035, WG plans, company input…

Voting
- Each person may cast 3 votes [3 points, 2 points, 1 point] on three different notes (no stacking the ballot box)
- Tally the points on each note
- Most points = highest priority

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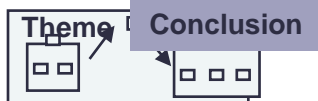
Conclusion

5 min to **conclude** & sign

Vote at Red or Lone Wolf Level:

Conclusion:
1, 2, 3 are key disruptors

Hints:
- The conclusion statement should be a fair and (by now) obvious answer to the theme question.
- Conjunctions (e.g. and, or, if) are allowed here to help tell the cause-and-effect story.

Conclusion
- Develop a conclusion statement to the theme question
- RED bold pen
- Block print (CAPS) the statement in the upper right corner
- Lower right corner: date, location, and each participant signs the sheet

- All: Introduction (20 min)
- Groups: KJ Method (70 min)
  - Agree on theme statement
  - Write and understand the facts
  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
  - **Vote on most important second-level issues and draw conclusions (**5 + 5 + **5 min)**
- All: Report-out (30 min)

The SE Methodologies stream guides the advancement of practices, methods, and tools for the effective engineering of systems to be fit for purpose **in the presence of varying scale, interrelatedness, complexity, non-determinism, and emerging technology innovations such as AI and agility.**

Agenda.
8:00 – 10:00 h

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- Groups: KJ Method (70 min)
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  - Group similar facts
  - Title the groups
  - Lay out groups and show relations between groups
  - Vote on most important second-level issues and draw conclusions
- **All: Report-out (30 min)**

Share your findings!

~3 mins per group to **share their theme and conclusion**
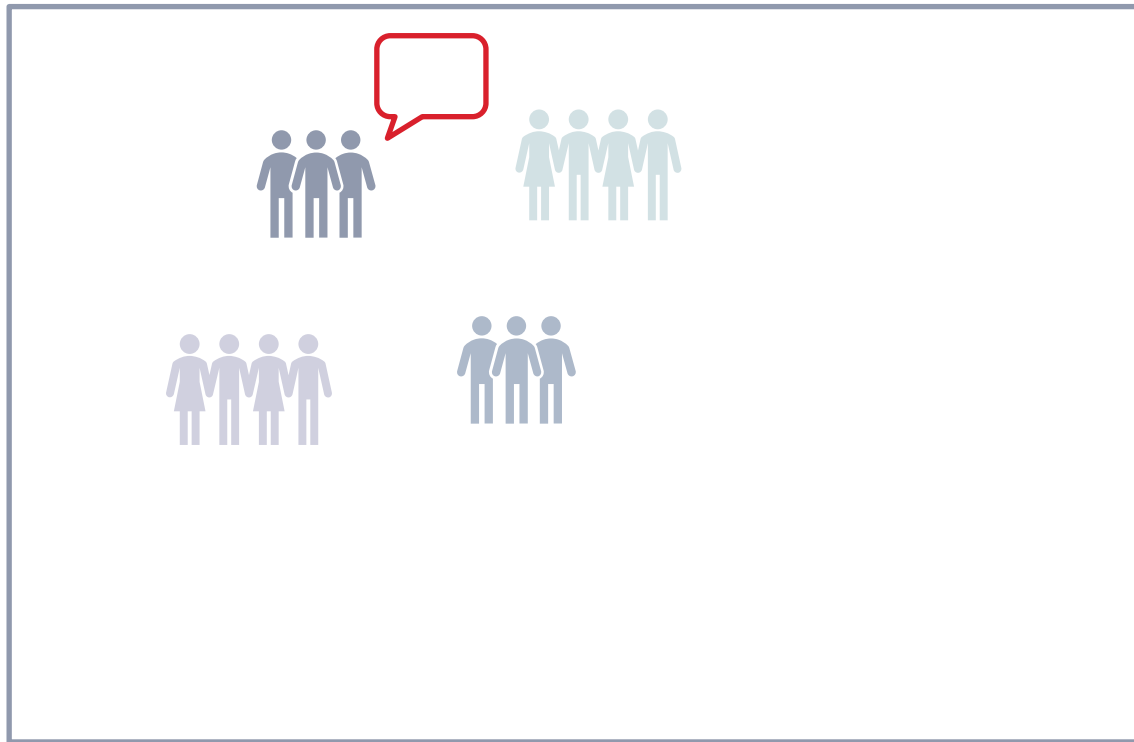
Share with the whole room

- Gather around the first group's KJ sheet
- Group spokesperson reads their Theme and Conclusion statement
- Rotate to the next group
- KJs will remain on the walls for discussion during the event

Systems Engineering Methodologies Stream

Chris Hoffman
Stream Lead "SE Methodologies"

e christopher.hoffman@incose.net

The SE Methodologies stream guides the advancement of practices, methods, and tools for the effective engineering of systems to be fit for purpose in the presence of varying scale, interrelatedness, complexity, non-determinism, and emerging technology innovations such as AI and agility.

The IW 2023 goal is to assess the adequacy of current INCOSE technical products and ongoing FuSE projects in this stream and identify gaps.

	SAT	SUN	MON	TUE
08:00		Elaborate disruptors:	Clarify problems / opportunities:	
08:30		1. Scale & Interrelatedness	1. Digital ecosystem	Wrap-up FuSE (for participants)
09:00		2. Complexity, Chaotic, Complicated, Clear	2. Software as the capability driver	
09:30	Break	3. A.I. for SE, other technologies	3. Continuous iterative model development	
10:00		4. TBD by participants	4. Evolution in learning systems	
			Break	
10:30	FuSE Kick-off			
11:00				Wrap-up FuSE
11:30				
12:00		Lunch		
12:30				
13:00				
13:30				
14:00	Introduction, Activities for 2023, Initial feedback, Opt-in participation			
14:30		Break		
15:00	Break			
15:30	Introduction, Activities for 2023, Initial feedback, Opt-in participation			
16:00				
16:30				

Systems Engineering Methodologies Stream

Chris Hoffman
Stream Lead "SE Methodologies"
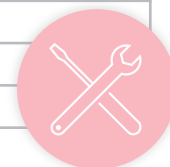
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	FuSE Kick-off		Break	

TOMORROW's PLAN

• We will brainstorm on solution concepts to mitigate or leverage the disrupters

• RESEARCH! Bring knowledge of what is already in process or planned

• We will prioritize the top concepts

• We will elaborate what is required for the top solution concepts to be successful

		Wrap-up FuSE	
15:30			
16:00	Introduction, Activities for 2023, Initial feedback, Opt-in participation		
16:30			

FuSE Targeted Events in 2023

Where to engage

International Workshop
Torrance, CA USA
28. – 31. JAN 23

EMEA WSEC
Sevilla, Spain
24. – 26. APR 23

International Symposium
Honolulu, HI USA
15. – 20. JUL 23

AOSEC
Bengaluru, India
11. – 14. OCT 23

Working Sessions
Virtual
Planned for CW 8 – 9

Working Sessions
Virtual
TBD

Going forward

How to participate?

- Join our SE Methodologies Meetings

- Visit the targeted events 2023

- Join <u>FuSE Yammer</u> Community

- Visit our Website <u>www.incose.org/fuse</u>

- Propose new or updated products, activities, services, initiatives… - Share with Chris Hoffman (<u>christopher.hoffman@incose.net</u>)

- Engage with WGs & Initiatives that are related to FuSE Methodologies goals with their activities & products

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⚶ SE Methodologies Meetings

Frequency: tbd – e.g., monthly, likely Friday late morning EST

Content:

- Monitoring & Control **(progress)**

- Health check of contributors **(progress)**

- Topics that streams are currently working on **(information)**

- Peer reviews of in-process work (e.g., TPP driven content) **(working)**

- program working meeting on programmatic aspects, like planning updates, replanning, etc. **(working)**

FUTURE OF SYSTEMS ENGINEERING (FUSE)

Vision: Inspire the global community to realize the SE Vision

The FuSE Program is organized in 4 streams.

Vision & Roadmaps

Foundations
The SE Foundations stream

Methodologies
The SE Methodologies stream

Application Extensions

Let's connect.

**Or find us on
www.incose.org/fuse**

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