26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

On the Automation of Intelligence, Sensing and Reconnaissance Systems in Low UDR Operations

Michael A. Schaffner
R&D Systems Engineering
Sandia National Laboratories

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

examiner.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

examiner.com

wikipedia.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

examiner.com

wikipedia.com

wikipedia.com

theverge.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

- *Automation* is increasingly a part of complex systems and our everyday lives.

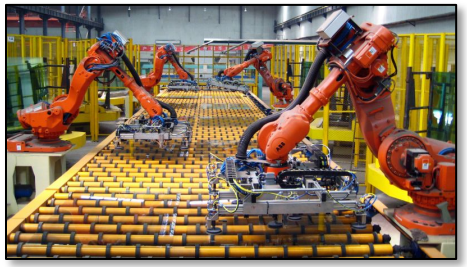
irobot.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

- *Automation* is increasingly a part of complex systems and our everyday lives.

irobot.com



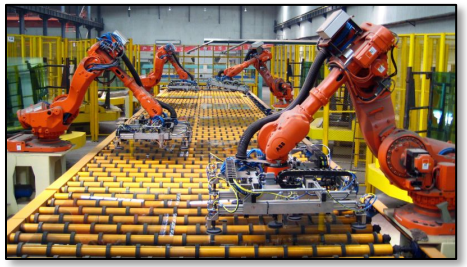
gizmodo.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.

- *Automation* is increasingly a part of complex systems and our everyday lives.

irobot.com



gizmodo.com

teslamotors.com

Context

- Intelligence, Sensing and Reconnaissance (*ISR*) operations have been used throughout history.
- *Automation* is increasingly a part of complex systems and our everyday lives.
- *What happens when the two meet?*

Motivation

- Imagine that you are designing a next-generation ISR system, and that this “Need” statement is given to you by a potential customer:

  – *“I don’t want human operators ‘in-the-loop’...What I want is humans ‘on-the-loop’, with the system telling human operators to pay attention where the really important stuff is happening.”*

Motivation

- Imagine that you are designing a next-generation ISR system, and that this "Need" statement is given to you by a potential customer:
  - *"I don't want human operators 'in-the-loop'...What I want is humans 'on-the-loop', with the system telling human operators to pay attention where the really important stuff is happening."*

- Is this a valid request for ISR systems in general?
- If it is not valid in general, what determines whether a specific ISR system could be automated in this fashion?

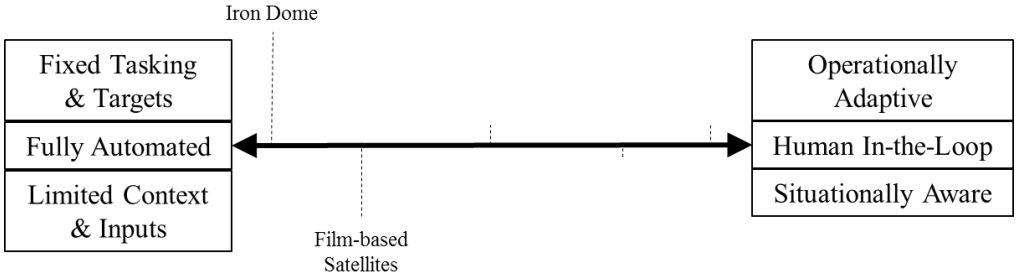
Goal

- Provide a framework for thinking about, and provide an associated measure to help more quickly assess, the appropriateness of automation in various ISR system operations

Conclusions

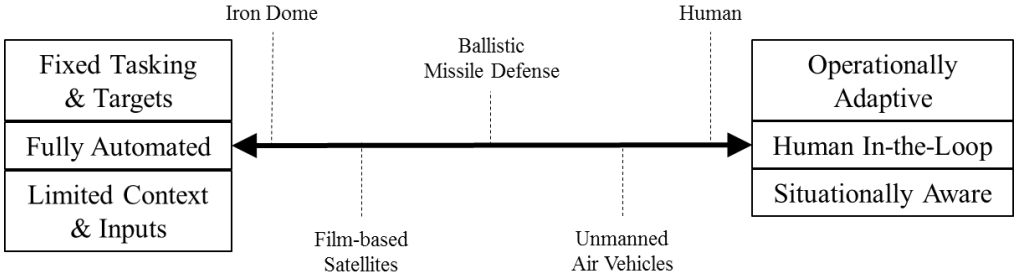
- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.

abcnews.go.com



Conclusions

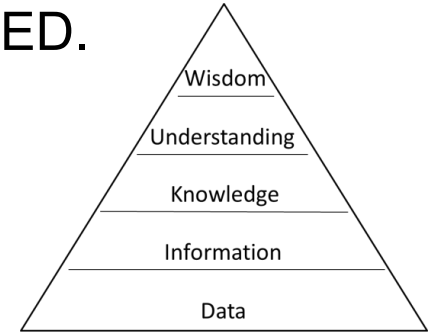
- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.
- Not all can be, though, at least for the foreseeable future.
  - Mobile systems, for example, allow (and often require) on-the-fly Processing and Exploitation of incoming data.



wikipedia.com

Conclusions

- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.
- Not all can be, though, at least for the foreseeable future.
  - A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and sense-making of data in the early phases of TCPED.

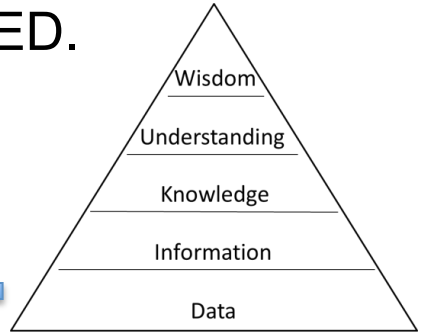


(Ackoff 1989)

Conclusions

- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.
- Not all can be, though, at least for the foreseeable future.
  - A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and sense-making of data in the early phases of TCPED.

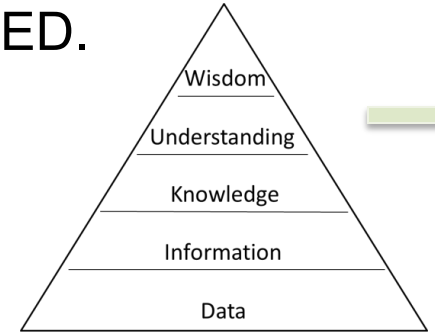
Measures of Sensor Data:
Richness, Diversity, Entropy, etc.



(Ackoff 1989)

Conclusions

- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.
- Not all can be, though, at least for the foreseeable future.
  - A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and sense-making of data in the early phases of TCPED.

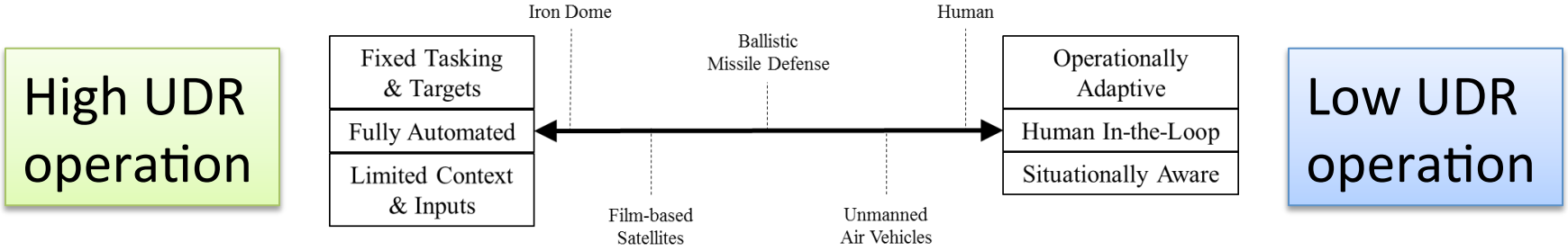


(Ackoff 1989)

Measures of Understanding:
Well-defined targets?
Signature target characteristic?
Limited set of targets?
(Richness, Diversity?)
Etc.

Conclusions

- Some ISR operations can (and have) been automated successfully to humans “on-the-loop”.
- Not all can be, though, at least for the foreseeable future.
  - A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and sense-making of data in the early phases of TCPED.



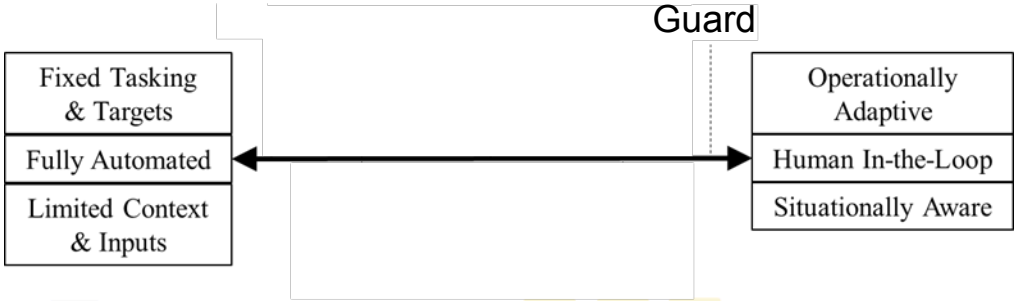
Case Application

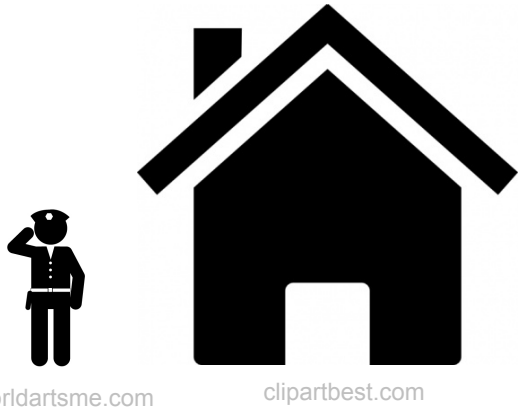
- Residential Security
  - Three alternatives considered:
    - Security Guard
    - Video Camera Suite
    - Proximity Sensors

clipartbest.com

Case Application

- Residential Security: 3 alternatives
  1. Security Guard



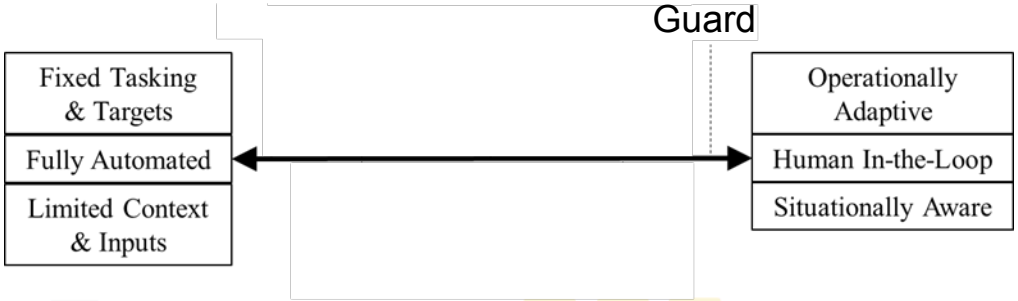


worldartsme.com clipartbest.com

Case Application

- Residential Security: 3 alternatives
  1. Security Guard

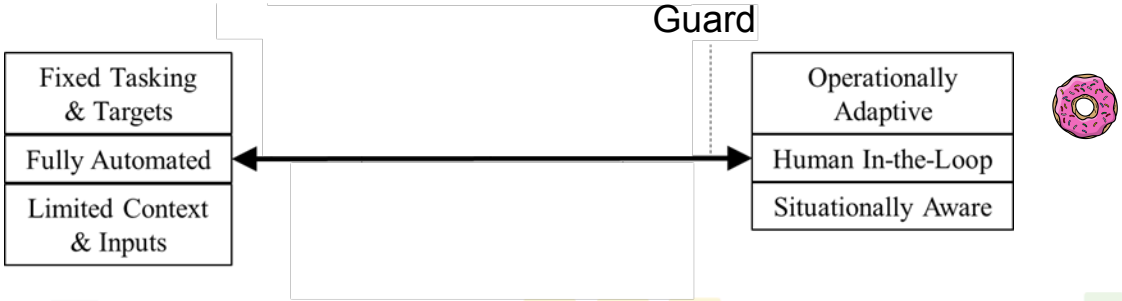
     -Very little problem definition needed



worldartsme.com clipartbest.com

Case Application

- Residential Security: 3 alternatives
  1. Security Guard

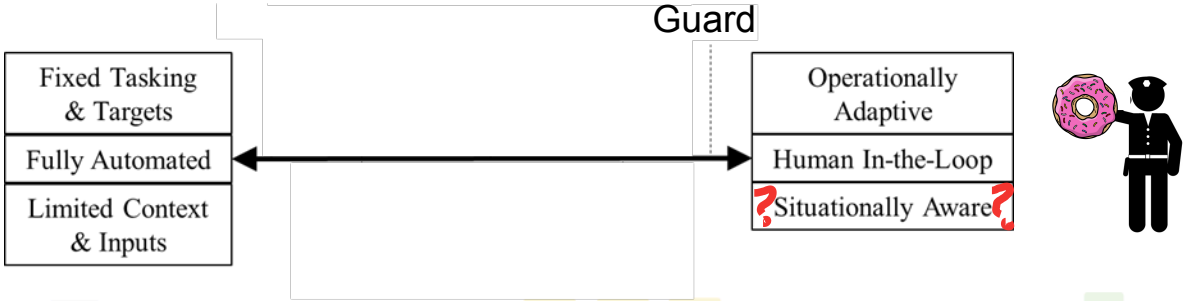


worldartsme.com

clipartbest.com

Case Application

- Residential Security: 3 alternatives
  1. Security Guard

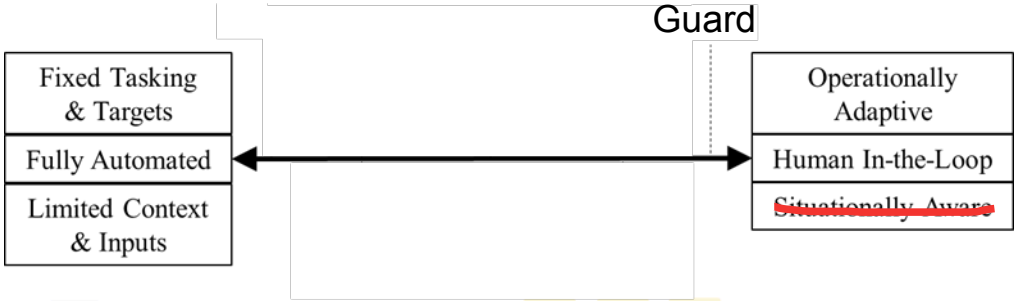


worldartsme.com

clipartbest.com

Case Application

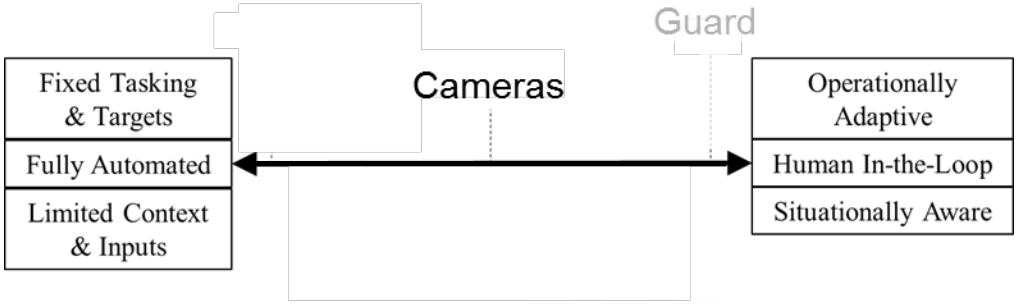
- Residential Security: 3 alternatives
  1. Security Guard



worldartsme.com clipartbest.com

Case Application

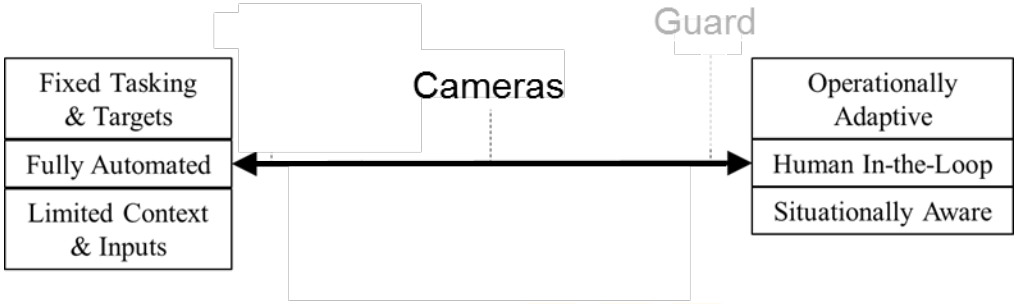
- Residential Security: 3 alternatives
  1. Security Guard
  2. Video Camera Suite



Case Application

- Residential Security: 3 alternatives
  1. Security Guard
  2. Video Camera Suite

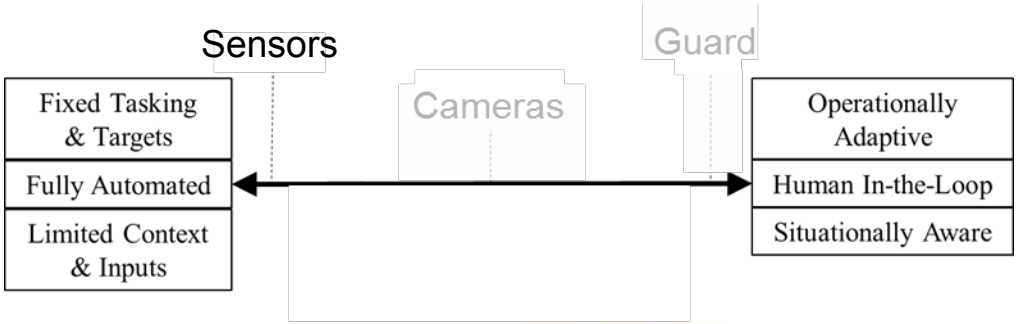
     -A bit more problem definition needed

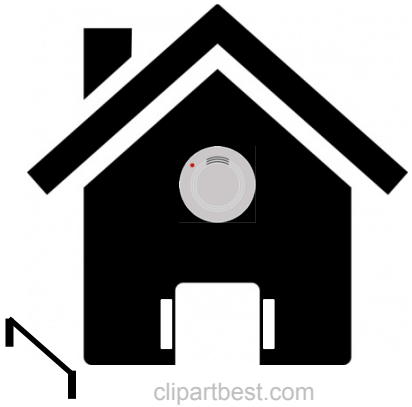


clipartbest.com

Case Application

- Residential Security: 3 alternatives
  1. Security Guard
  2. Video Camera Suite
  3. Proximity Sensors

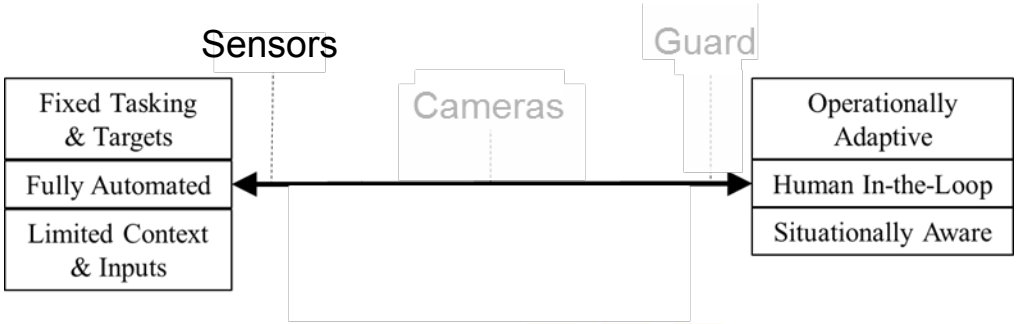




Case Application

- Residential Security: 3 alternatives

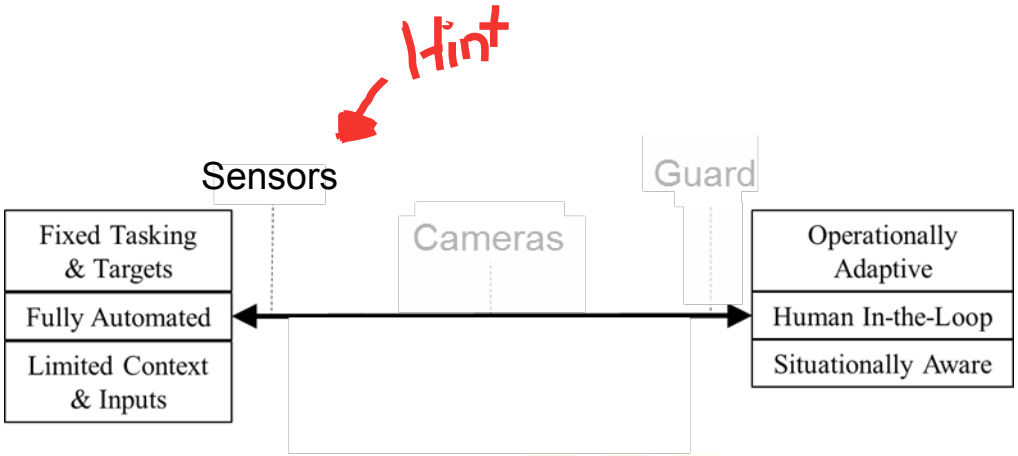
  Where is automation most appropriate?



Case Application

- Residential Security: 3 alternatives

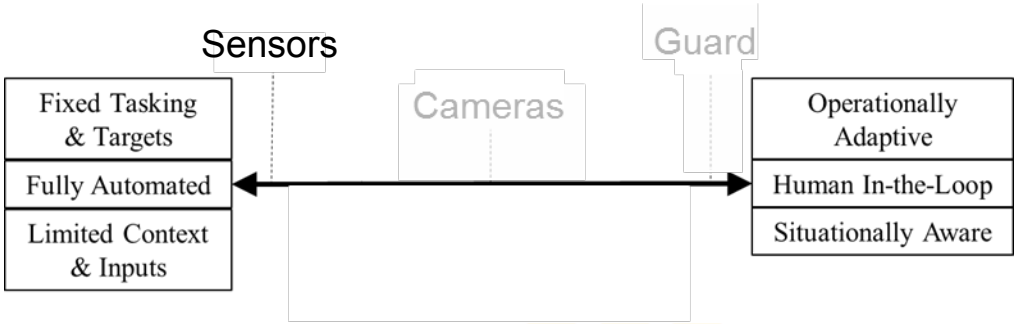
  Where is automation most appropriate?



Case Application

- Residential Security: 3 alternatives

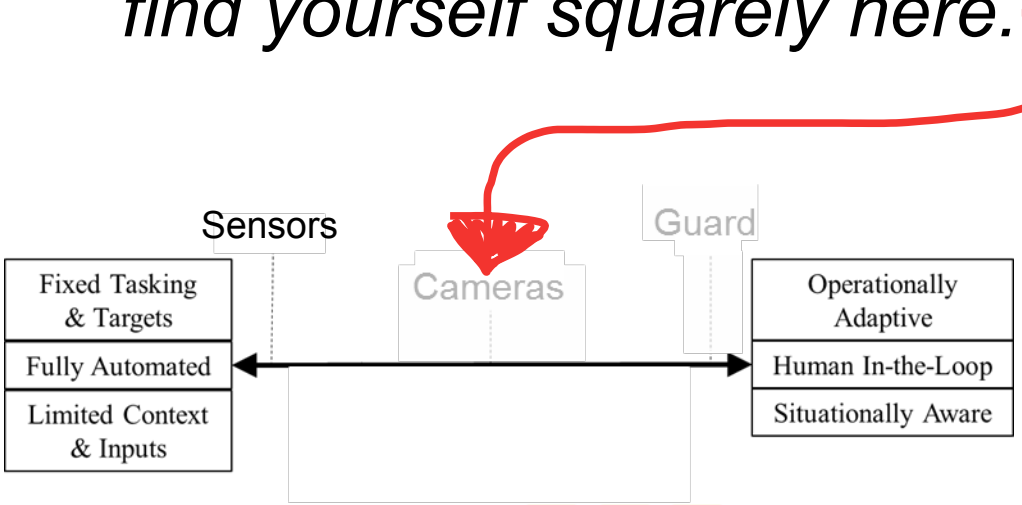
  Beginning on the left and traversing to the right requires problem definition at the start.



Case Application

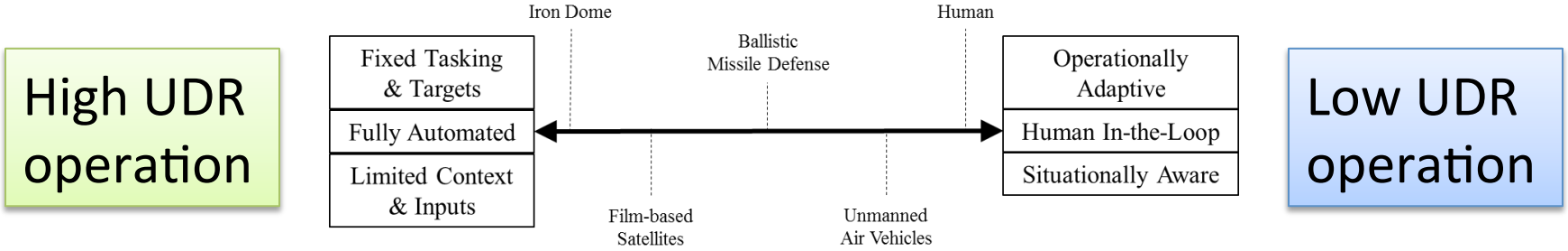
- Residential Security: 3 alternatives

  On an existing or continuing program, you might find yourself squarely here.



Conclusions

- A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and contribution to understanding.
- ***UDR can be a useful indicator in determining the appropriateness of automation for alternative system operations*.**



Conclusions

- A low **Understanding-to-Data Ratio** (**UDR**) of operation requires on-the-fly clarification and contribution to understanding.
- ***UDR can be a useful indicator in determining the appropriateness of automation for alternative system***

Traits of High UDR Operations
-Limited set of questions and targets -Clearly defined questions and targets -Many assumptions about implications of data -Designed to infer limited set of outcomes -Limited, specific data collects -Limited, specific operating contexts

Traits of Low UDR Operations
-Unbounded set of questions and targets -Ill-defined, evolving questions and targets -Assumptions/implications questioned -Exploratory and explanatory -“Big” data (i.e., streaming HD video) -Variety of operating contexts

Questions?

26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

The paper is intended in part to provide an initial collection of references if interested.

Feedback welcome!

- maschaf@sandia.gov

References

Ackoff, R. L. 1989. "From data to wisdom." *Journal of Applied Systems Analysis,* Volume 16: 3-9.
(and many more in the paper…)