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# Scoping Software Process Models

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Initial Concepts and Experience from  
Defining Space Standards

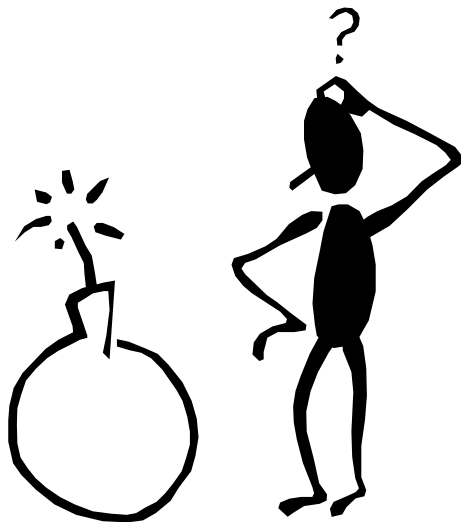
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## Introduction & Existing Problems



- Support for describing software processes prescriptively has ample improvement potential
    - Appropriate level of variability (not too strict, no arbitrary variability?)
    - Handling of unforeseen variability?
  - Typically, many process variants within organizations
  - But: variability is a cost driver
  - Explicit capture and documentation of variants
    - Provides flexibility
    - Limits variability
- *Missing: Method for systematically determining necessary variability*

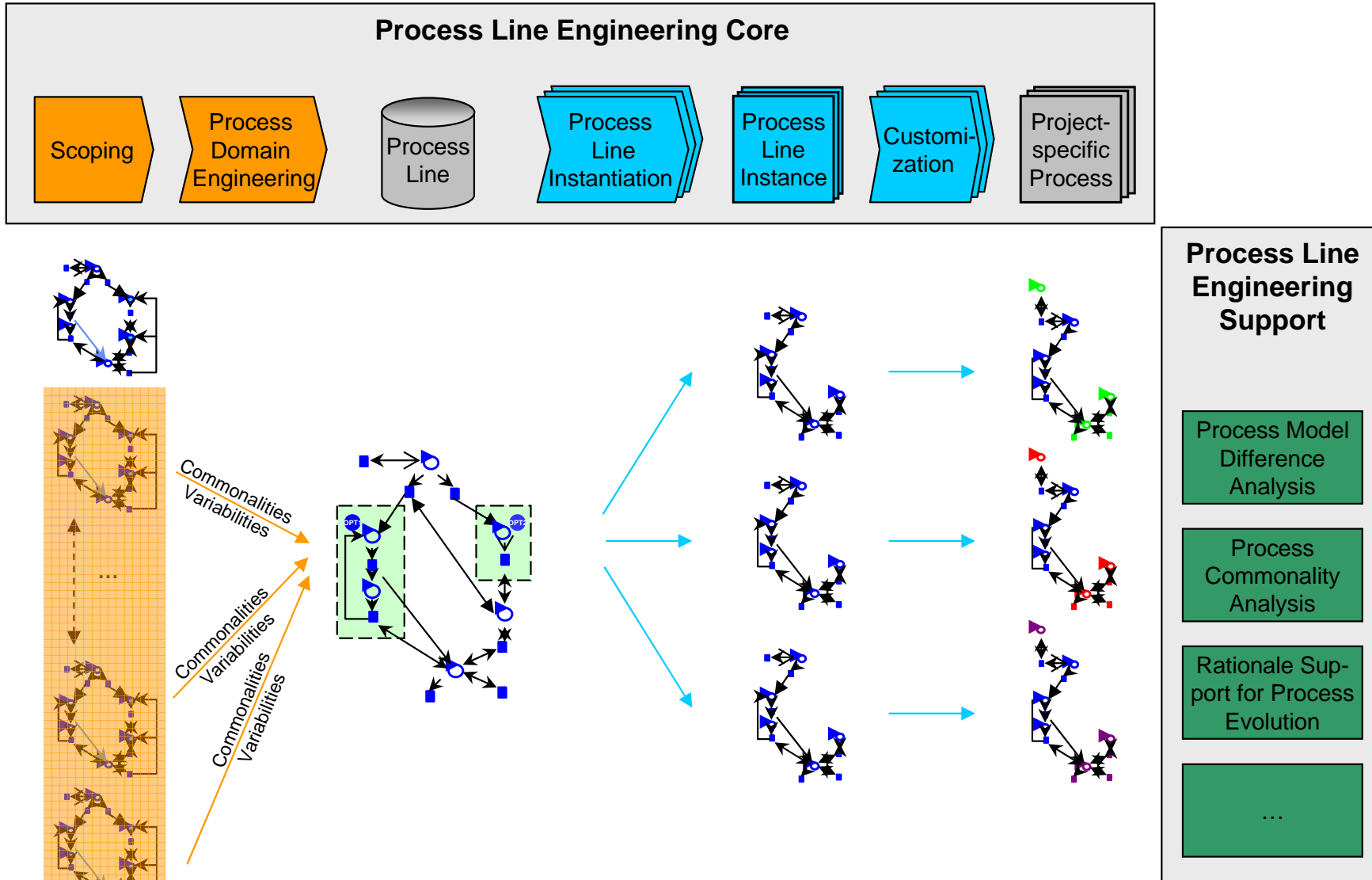
## Requirements for a Solution

- Support software and system development by providing an appropriate selection of necessary processes
  - Characterize software products, projects, and processes accordingly
  - Distinguish stable process parts from variable ones
  - Incorporate unanticipated variability in a controlled manner
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- Store stable and variable parts within one process model
  - Cost-efficiently instantiate such a combined model into a project-specific process model without variability

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# Scoping Software Process Models

## Software Process Lines – The Vision



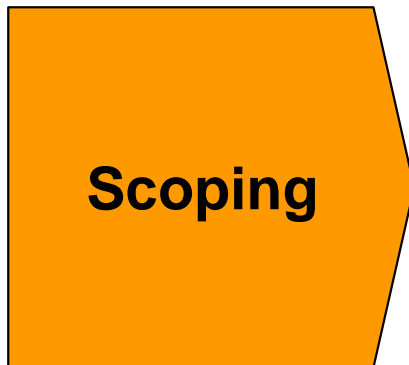
## Software Process Lines

- Software Process Line actively prepares an organization's processes for a number of anticipated needs
  - Possibly tailors them further to incorporate unanticipated changes during project runtime
  - Classic process tailoring typically modifies a process individually for a specific project
- Software *Process* Line approach similar to Software *Product* Line approach

• Scoping characterizes products, projects, processes, then selects suitable processes for organization

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## Scoping Software Processes



- Goal: Determine what to include in a software process line, and what not
  - Based on characteristics of
    - products
    - projects
    - processes
  - Product / project characteristics = demand for process capabilities
  - Process characteristics = process capabilities
  - Matching product / project characteristics to process characteristics
- Scope of (future) organization processes

## Scoping Software Processes – Product Characteristics

- Product characteristics recorded in *product map* for current, future, and potential products
- Example *product characteristics*
  - safety-critical?
  - requirements known at beginning of development?

		Existing Products			Future Products				Potential Products		
		P1	P2	P3	P4	P5	P6	...	P7	P8	P9
Product Characteristics	Safety critical	1	3	2	2	3	2		2	3	3
	Reqs known	3	3	2	2	3	3		3	3	3
	...										

## Scoping Software Processes – Project Characteristics

- Project characteristics recorded in *project map* for existing/historical, future, and potential projects
- Example *project characteristics*
  - Project must follow a certain development standard
  - Project is performed in a distributed manner

		Existing Projects			Future Projects				Potential Projects		
		P1	P2	P3	P4	P5	P6	...	P7	P8	P9
Project Characteristics	SPIICE compliance	1	1	2	2	2	3		2	3	3
	distributed	3	2	3	3	1	3		2	3	1
	...										

## Scoping Software Processes – Process Characteristics

- Processes characterized using the same attributes as for product / project characterization
- Process characteristics recorded in *process map* for existing, future, and potential processes
  - Process capabilities
  - Counterpart to demands of products and projects

		Existing Processes			Future Processes			Potential Processes		
		P1	P2	P3	P4	P5	P6	P7	P8	P9
Process Characteristics	SPICE compliant	1	1	2	2	1	1	3	1	1
	Distributed	2	1	2	2	2	1	3	1	2
	61508 compliant	1	2	3	2	3	2	3	2	2

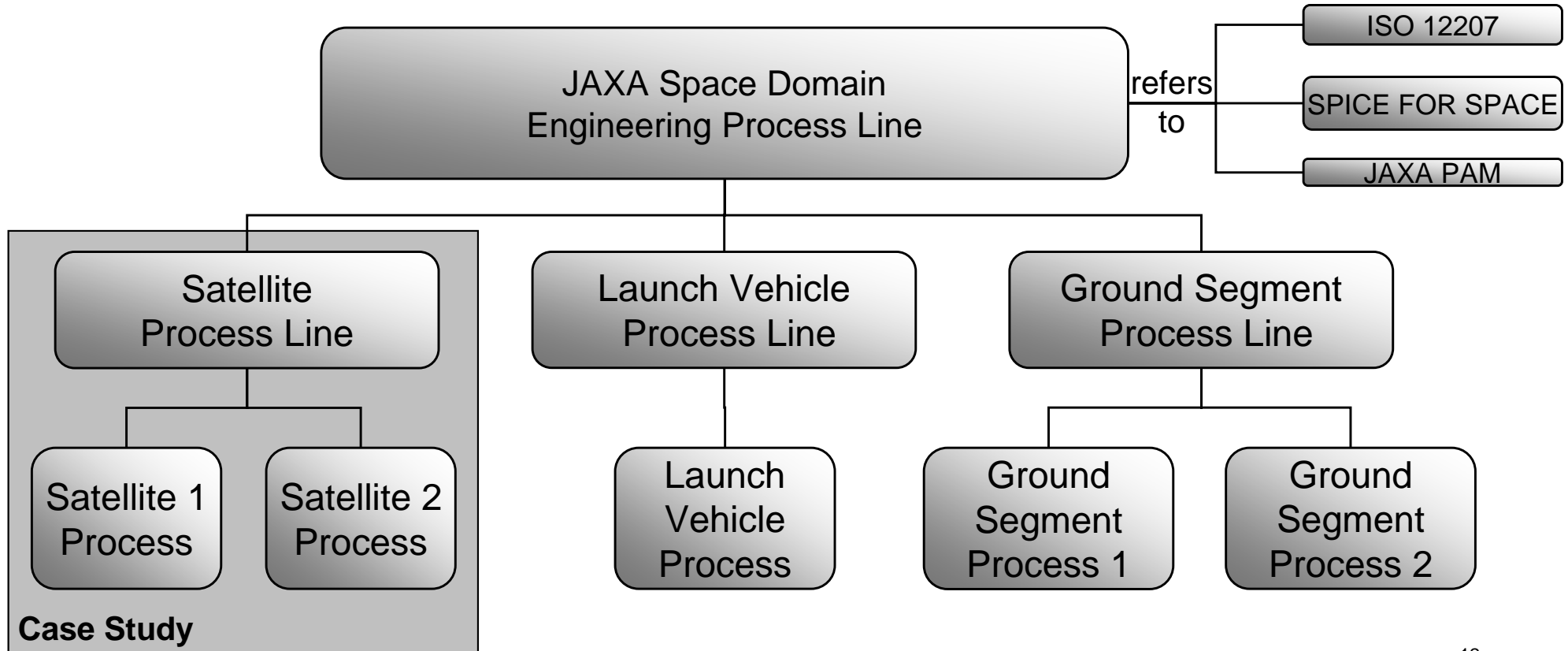
# Scoping Software Process Models

## Scoping Software Processes – Matching

- Product / project characteristics = demand for process capabilities
- Processes characteristics = process capabilities
- Product demands: safety criticality rising, requirements mostly known
- Project demands: SPICE compliance increasingly important, distribution inconsistent
- → Scope: SPICE-compliant, safety-supporting process with optional support for distributed processes

		Existing Processes			Future Processes			Potential Processes		
		P1	P2	P3	P4	P5	P6	P7	P8	P9
Process Characteristics	SPICE compliant	1	1	2	2	1	1	3	1	1
	Distributed	2	1	2	2	2	1	3	1	2
	61508 compliant	1	2	3	2	3	2	3	2	2

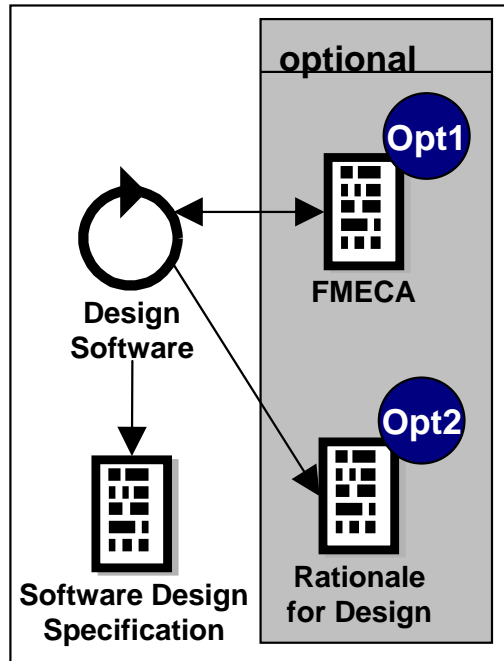
## Piloting of the Method in the Space Domain



## Piloting of the Method in the Space Domain – Context

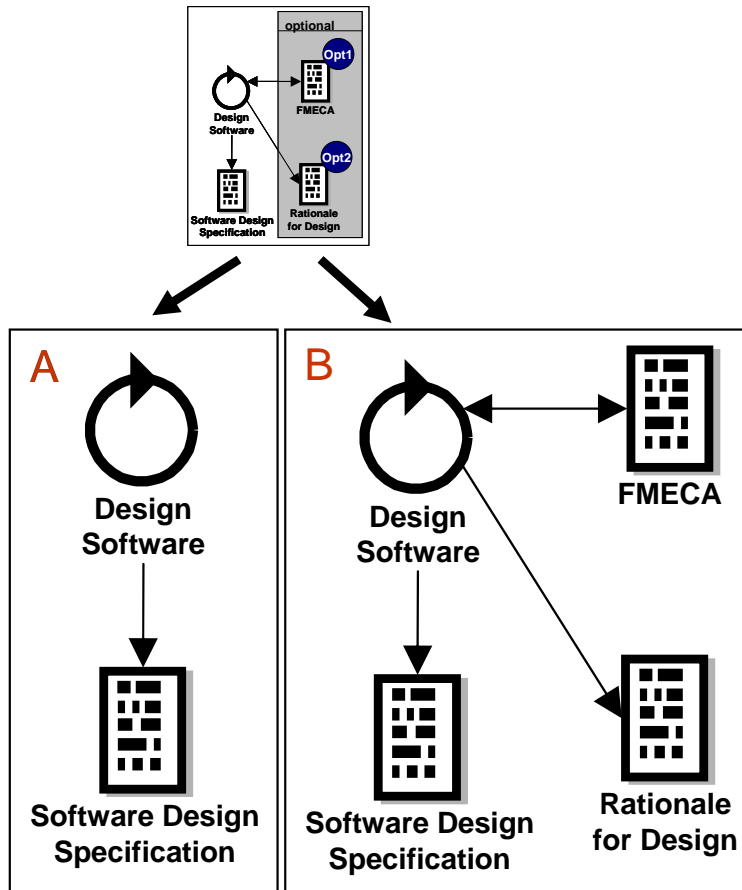
- Goal: Proof of feasibility
- Context
  - Characterization for satellite process line
  - 2 satellite development projects characterized
  - Project = product!
  - All characterizations based on expert estimates
- Developed software process line published as appendix to official standard

## Piloting of the Method in the Space Domain – Excerpt



- Rules for solving variation points
  - Two (independent) options
  - (Opt1) *if (collaboration type == international) then (produce FMECA)*
  - (Opt2) *if (mission type == engineering) then (produce Rationale for Design)*

## Piloting of the Method in the Space Domain – Excerpt



- Rules for solving variation points
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  - (Opt1) *if (collaboration type == international) then (produce FMECA)*
  - (Opt2) *if (mission type == engineering) then (produce Rationale for Design)*
- National science type projects: process instance **A**
- International engineering type projects: process instance **B**

## Experiences

- Product characteristics
  - Soft product characteristics (size, complexity) did not lead to qualitative process changes, but quantitative ones (e.g., number of reviews increased)
  - Not modeled, instead formulated as requirements for suppliers' processes
- Project characteristics
  - Qualitative process changes (e.g., new activity *Analyze hardware/software interaction* for *international* cooperation type projects, producing new artifact *FMECA*)
  - One process variant: lightweight version for exploratory *science* type projects

## Experiences (2)

		Satellites		Launch
		Sat1	Sat2	LV1
Project Characteristics	Collaboration type	National	International	
	Mission type	Engineering	Science	
	Subsystem	1, 2, 3	3	
	Supplier	1, 2	1	
	...			

		Satellites			
		Sat1			Sat2
		Subsystem1	Subsystem2	Subsystem3	Subsystem
Product Characteristics	Complexity	3	2	1	1
	Criticality	2	3	1	1
	Size	3	3	2	2
	Stable Requirements	yes	yes	yes	no
	...				

- Conflicts

- Collaboration type “international” → documentation in English upon request, suggesting one set of potential suppliers
- Mission type suggested different set
- Solved by prioritizing characteristics

- Effort

- Scoping helped concentrate on relevant processes
- Maintenance complexity for process line is expected to be lower than for two individual standards

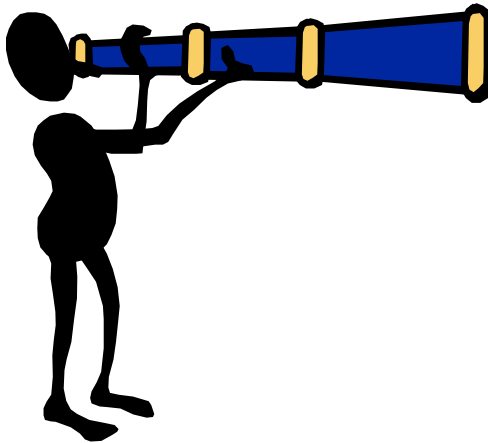
## Experiences (3)

- Resulting model
  - 76 activities
  - 54 artifacts
  - 18 graphical views depicting product flow
  - 18 graphical views depicting control flow
  - 8 variation points
- Transfer into daily practice is challenging
  - aerospace domain changes slowly
  - many stakeholders
  - consequences of failures potentially catastrophic

## About the Requirements...

- ✓ • Support software product development by providing an appropriate selection of necessary processes
  - ✓ • Characterize software products, projects, and processes accordingly
  - ✓ • Distinguish stable process parts from variable ones
  - ? • Incorporate unanticipated variability in a controlled manner
- 
- ~ • Store stable and variable parts within one process model (optional: yes, variants: no)
  - ✗ • Cost-efficiently instantiate such a combined model into a project-specific process model without variability

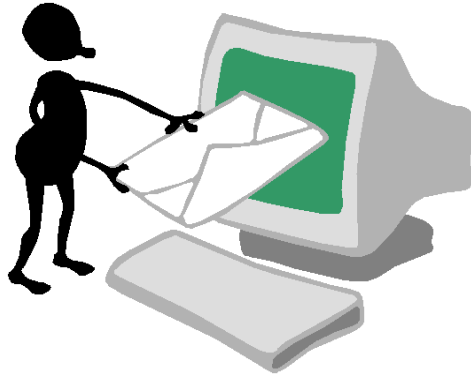
## Conclusions & Outlook



- Scoping approach limits complexity of organizational processes
- Characterizations & matching feasible for industry application
- Expand the process line
  - horizontally to other branches (launch vehicle, ground segment)
  - vertically (JAXA-wide)
- Open research questions
  - Decision models?
  - Limit characterization attribute values?
  - Limit number of characteristics and variation points?

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**Thank you for your attention!**



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# Questions?