CMU Task RT-119
—
Systemic Assurance

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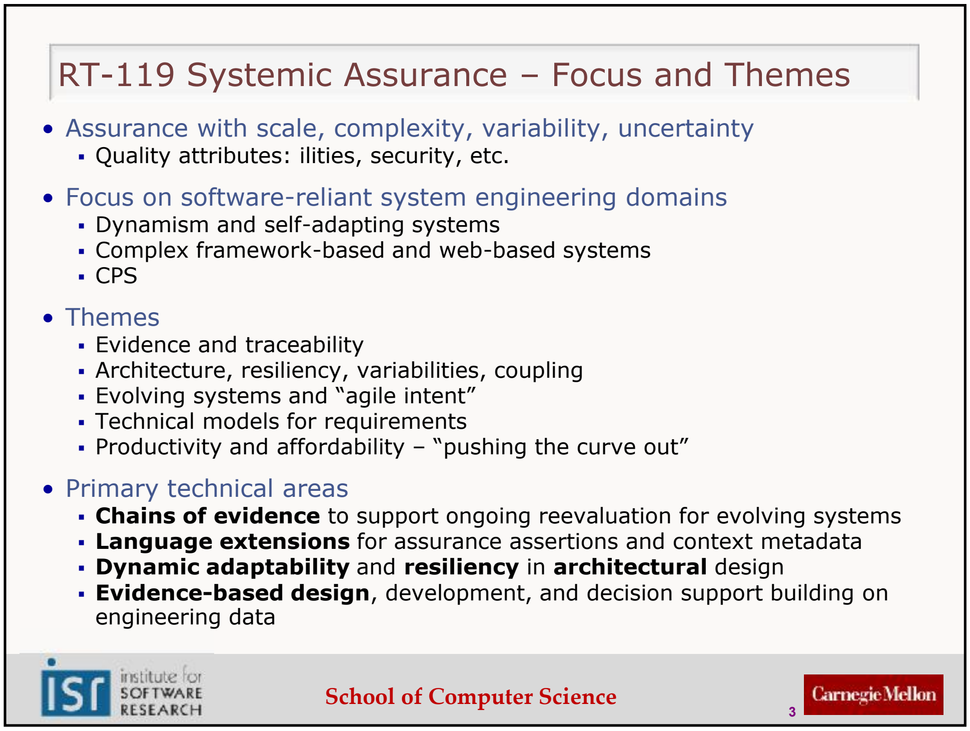
CMU RT-119 faculty and team

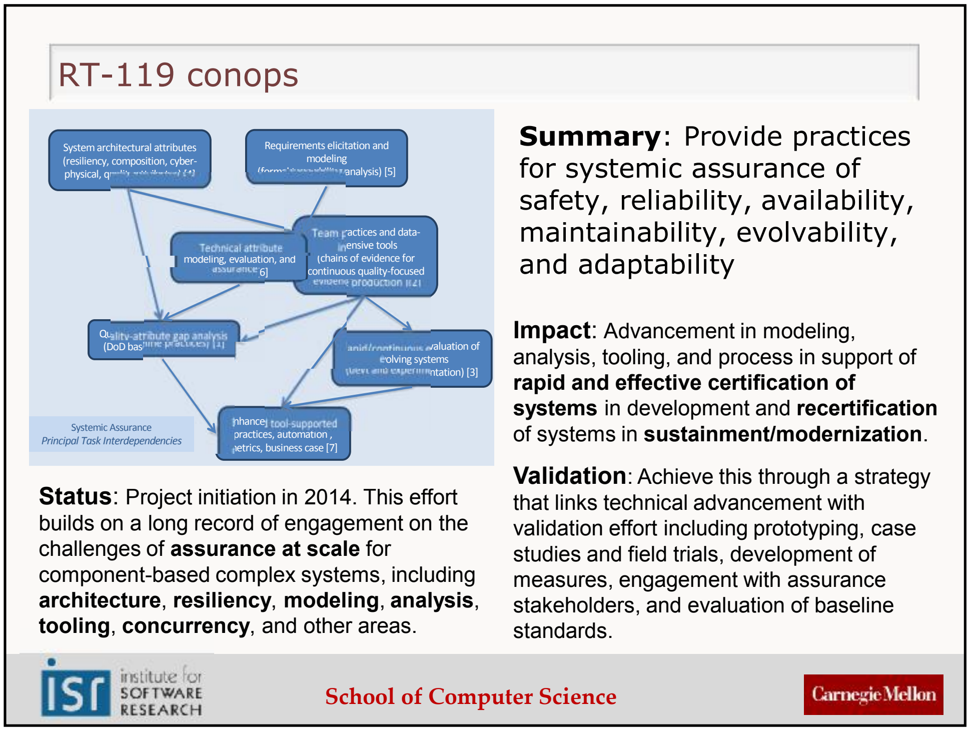
- Bill **Scherlis**, PI
- Claire **Le Goues**
- Travis **Breaux**
- Christian **Kästner**
- David **Garlan**
- Bradley **Schmerl**
- Joshua **Sunshine**
- Jonathan **Aldrich**
- *Multiple PhD students*

We are prepared for the risks, the uncertainties,
and the dangers of software-intensive systems engineering



RT-119 Systemic Assurance – Focus and Themes

- Assurance with scale, complexity, variability, uncertainty
  - Quality attributes: ilities, security, etc.
- Focus on software-reliant system engineering domains
  - Dynamism and self-adapting systems
  - Complex framework-based and web-based systems
  - CPS
- Themes
  - Evidence and traceability
  - Architecture, resiliency, variabilities, coupling
  - Evolving systems and "agile intent"
  - Technical models for requirements
  - Productivity and affordability – "pushing the curve out"
- Primary technical areas
  - **Chains of evidence** to support ongoing reevaluation for evolving systems
  - **Language extensions** for assurance assertions and context metadata
  - **Dynamic adaptability** and **resiliency** in **architectural** design
  - **Evidence-based design**, development, and decision support building on engineering data



RT-119 conops

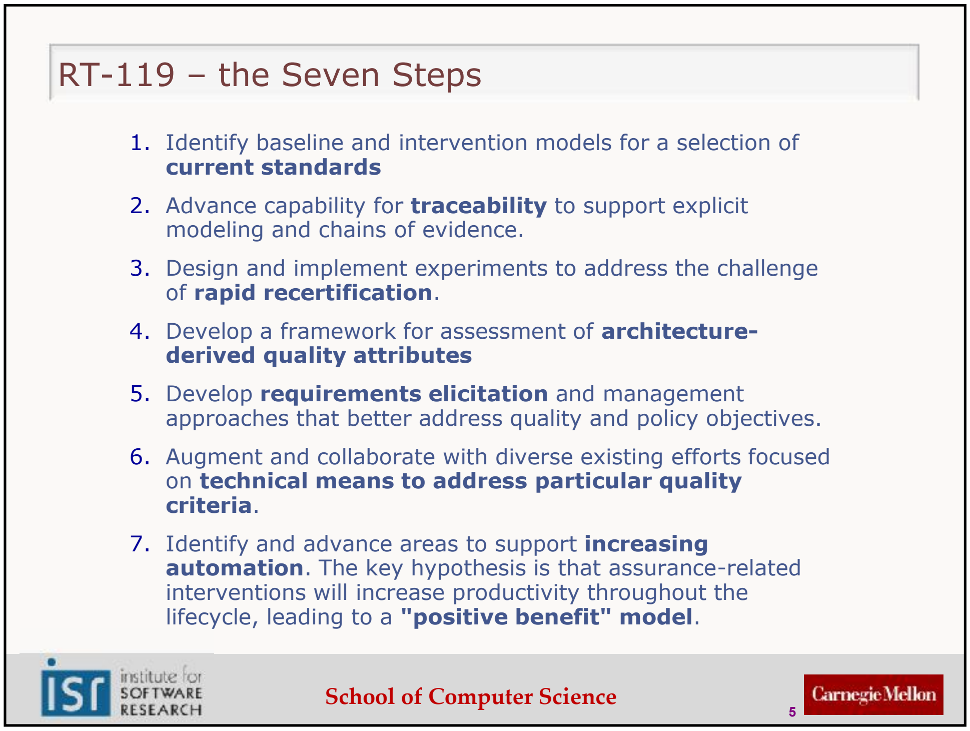
System architectural attributes (resiliency, composition, cyber-physical, quality attributes) [4]
Requirements elicitation and modeling (formal traceability analysis) [5]
Technical attribute modeling, evaluation, and assurance [6]
Team practices and data-intensive tools (chains of evidence for continuous quality-focused evidence production [2]
Quality-attribute gap analysis (DoD baseline practices) [1]
Rapid/continuous evaluation of evolving systems (devt and experimentation) [3]
Enhanced tool-supported practices, automation, metrics, business case [7]
Systemic Assurance
Principal Task Interdependencies

Status: Project initiation in 2014. This effort builds on a long record of engagement on the challenges of **assurance at scale** for component-based complex systems, including **architecture**, **resiliency**, **modeling**, **analysis**, **tooling**, **concurrency**, and other areas.

Summary: Provide practices for systemic assurance of safety, reliability, availability, maintainability, evolvability, and adaptability

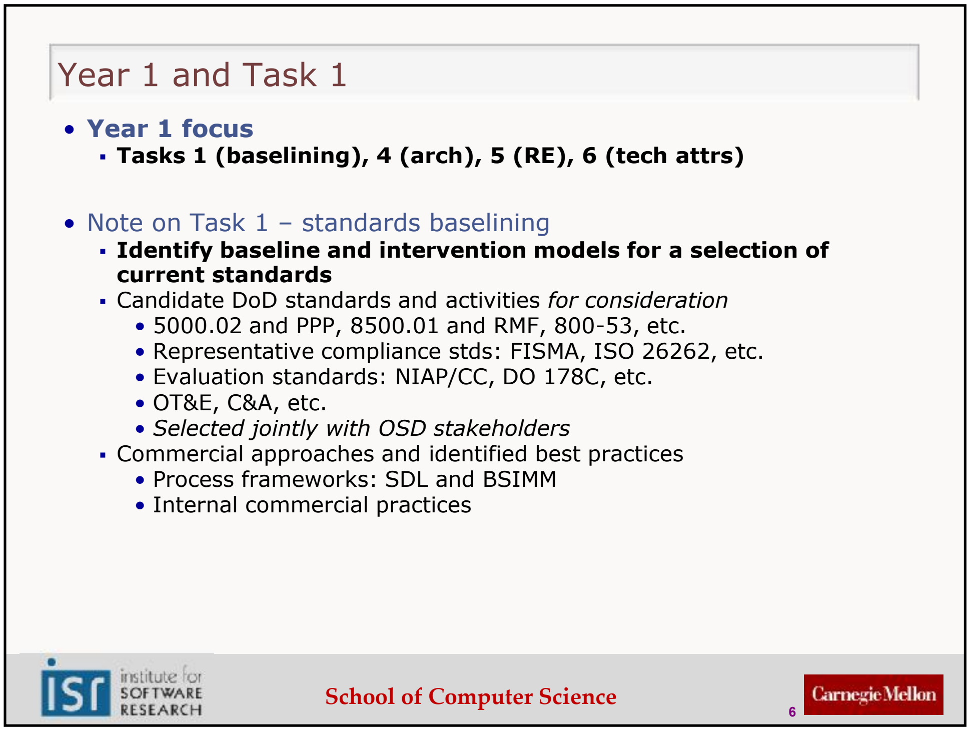
Impact: Advancement in modeling, analysis, tooling, and process in support of **rapid and effective certification of systems** in development and **recertification** of systems in **sustainment/modernization**.

Validation: Achieve this through a strategy that links technical advancement with validation effort including prototyping, case studies and field trials, development of measures, engagement with assurance stakeholders, and evaluation of baseline standards.



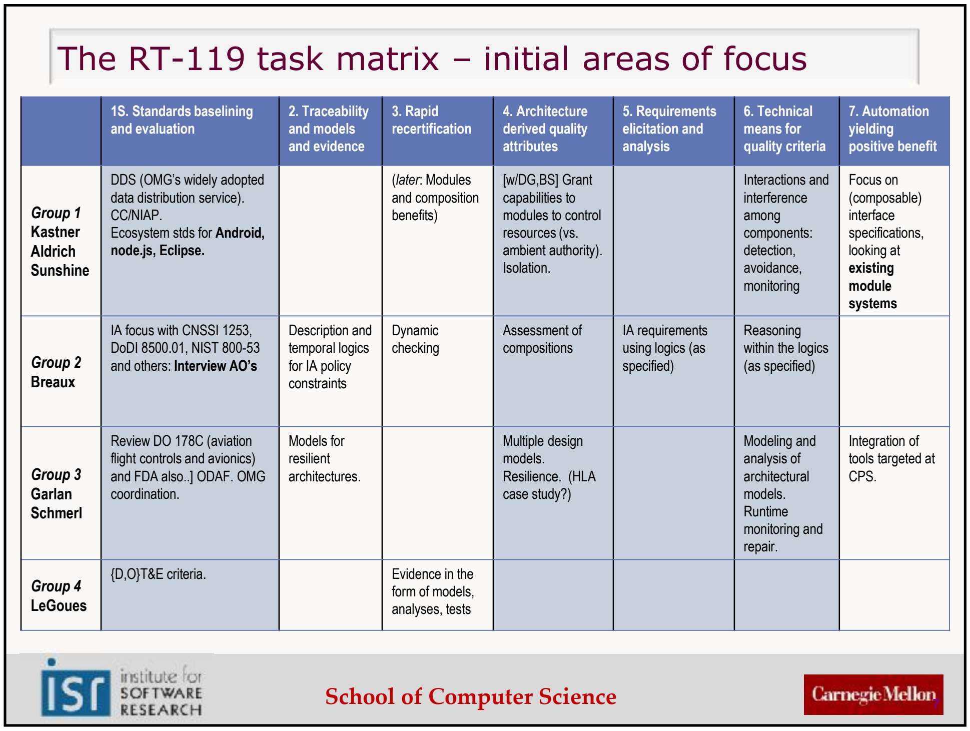
RT-119 – the Seven Steps

1. Identify baseline and intervention models for a selection of **current standards**
2. Advance capability for **traceability** to support explicit modeling and chains of evidence.
3. Design and implement experiments to address the challenge of **rapid recertification**.
4. Develop a framework for assessment of **architecture-derived quality attributes**
5. Develop **requirements elicitation** and management approaches that better address quality and policy objectives.
6. Augment and collaborate with diverse existing efforts focused on **technical means to address particular quality criteria**.
7. Identify and advance areas to support **increasing automation**. The key hypothesis is that assurance-related interventions will increase productivity throughout the lifecycle, leading to a **"positive benefit" model**.



Year 1 and Task 1

- **Year 1 focus**
  - **Tasks 1 (baselining), 4 (arch), 5 (RE), 6 (tech attrs)**
- Note on Task 1 – standards baselining
  - **Identify baseline and intervention models for a selection of current standards**
  - Candidate DoD standards and activities *for consideration*
    - 5000.02 and PPP, 8500.01 and RMF, 800-53, etc.
    - Representative compliance stds: FISMA, ISO 26262, etc.
    - Evaluation standards: NIAP/CC, DO 178C, etc.
    - OT&E, C&A, etc.
    - *Selected jointly with OSD stakeholders*
  - Commercial approaches and identified best practices
    - Process frameworks: SDL and BSIMM
    - Internal commercial practices



The RT-119 task matrix – initial areas of focus

	1S. Standards baselining and evaluation	2. Traceability and models and evidence	3. Rapid recertification	4. Architecture derived quality attributes	5. Requirements elicitation and analysis	6. Technical means for quality criteria	7. Automation yielding positive benefit
Group 1 **Kastner Aldrich Sunshine**	DDS (OMG's widely adopted data distribution service). CC/NIAP. Ecosystem stds for **Android, node.js, Eclipse.**		(*later*: Modules and composition benefits)	[w/DG,BS] Grant capabilities to modules to control resources (vs. ambient authority). Isolation.		Interactions and interference among components: detection, avoidance, monitoring	Focus on (composable) interface specifications, looking at **existing module systems**
Group 2 **Breaux**	IA focus with CNSSI 1253, DoDI 8500.01, NIST 800-53 and others: **Interview AO's**	Description and temporal logics for IA policy constraints	Dynamic checking	Assessment of compositions	IA requirements using logics (as specified)	Reasoning within the logics (as specified)	
Group 3 **Garlan Schmerl**	Review DO 178C (aviation flight controls and avionics) and FDA also..] ODAF. OMG coordination.	Models for resilient architectures.		Multiple design models. Resilience. (HLA case study?)		Modeling and analysis of architectural models. Runtime monitoring and repair.	Integration of tools targeted at CPS.
Group 4 **LeGoues**	{D,O}T&E criteria.		Evidence in the form of models, analyses, tests				

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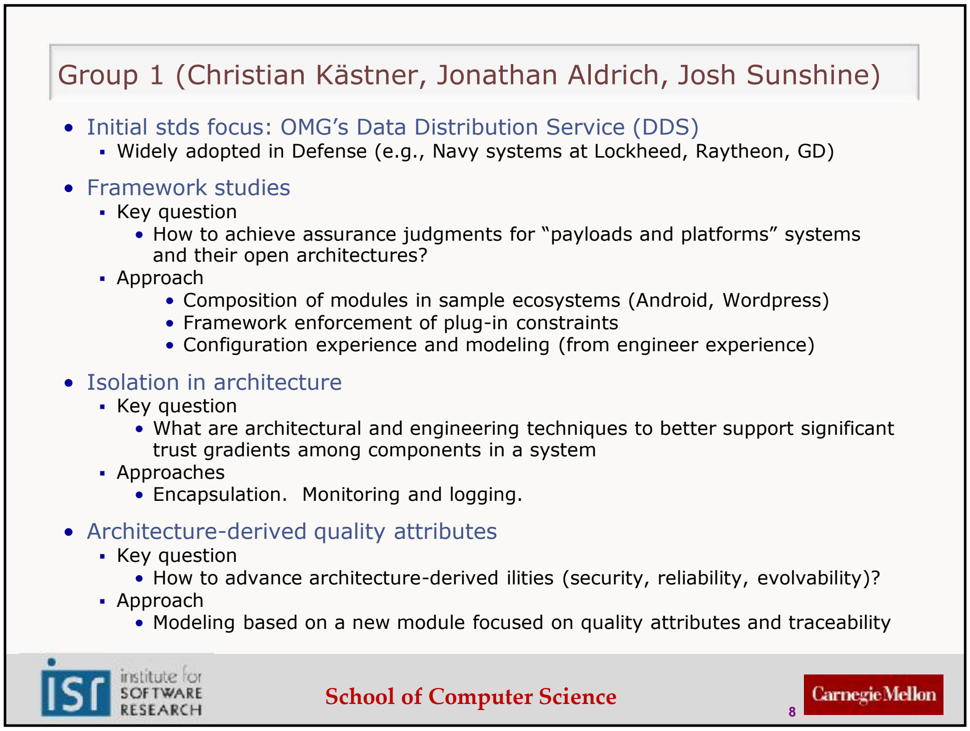

Group 1 (Christian Kästner, Jonathan Aldrich, Josh Sunshine)

- Initial stds focus: OMG's Data Distribution Service (DDS)
  - Widely adopted in Defense (e.g., Navy systems at Lockheed, Raytheon, GD)
- Framework studies
  - Key question
    - How to achieve assurance judgments for "payloads and platforms" systems and their open architectures?
  - Approach
    - Composition of modules in sample ecosystems (Android, Wordpress)
    - Framework enforcement of plug-in constraints
    - Configuration experience and modeling (from engineer experience)
- Isolation in architecture
  - Key question
    - What are architectural and engineering techniques to better support significant trust gradients among components in a system
  - Approaches
    - Encapsulation. Monitoring and logging.
- Architecture-derived quality attributes
  - Key question
    - How to advance architecture-derived ilities (security, reliability, evolvability)?
  - Approach
    - Modeling based on a new module focused on quality attributes and traceability

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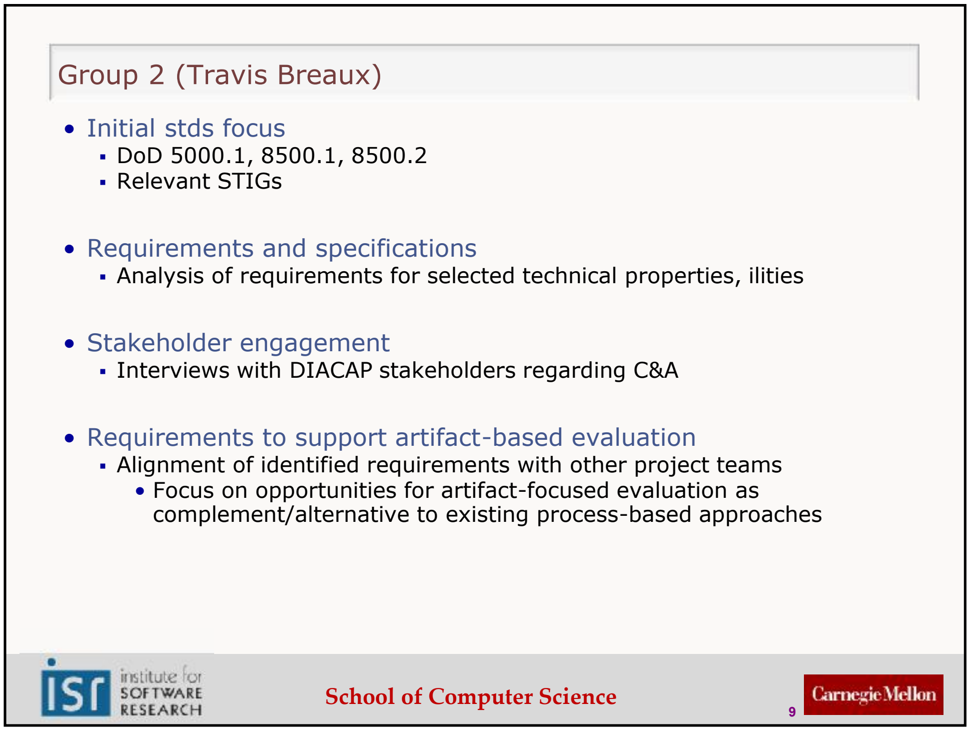

Group 2 (Travis Breaux)

- Initial stds focus
  - DoD 5000.1, 8500.1, 8500.2
  - Relevant STIGs
- Requirements and specifications
  - Analysis of requirements for selected technical properties, ilities
- Stakeholder engagement
  - Interviews with DIACAP stakeholders regarding C&A
- Requirements to support artifact-based evaluation
  - Alignment of identified requirements with other project teams
    - Focus on opportunities for artifact-focused evaluation as complement/alternative to existing process-based approaches

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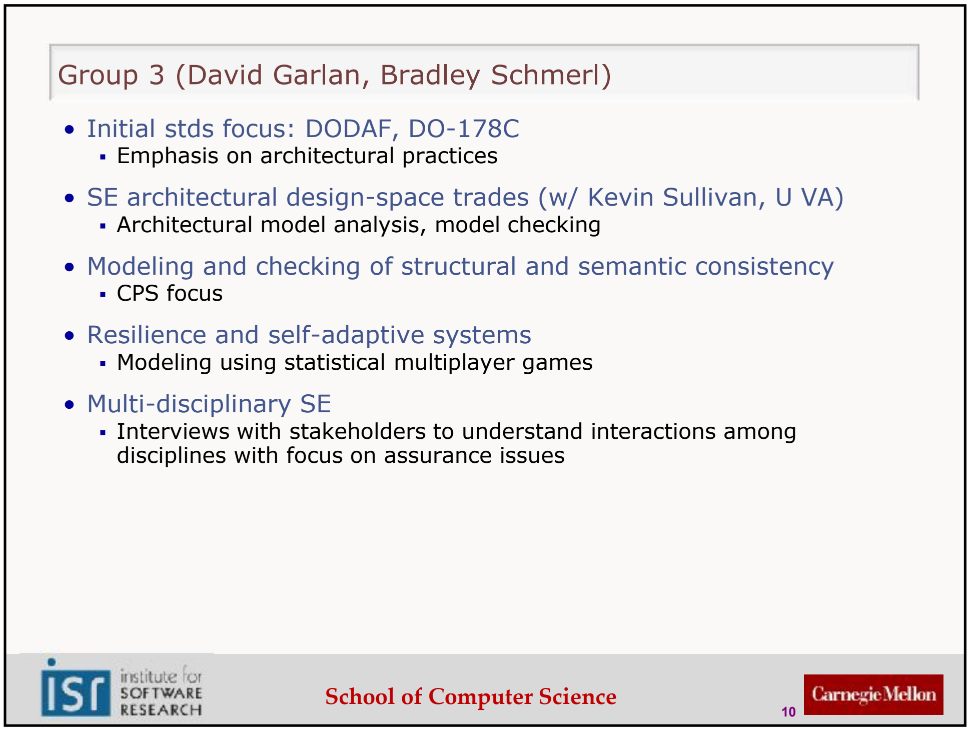

Group 3 (David Garlan, Bradley Schmerl)

- Initial stds focus: DODAF, DO-178C
  - Emphasis on architectural practices
- SE architectural design-space trades (w/ Kevin Sullivan, U VA)
  - Architectural model analysis, model checking
- Modeling and checking of structural and semantic consistency
  - CPS focus
- Resilience and self-adaptive systems
  - Modeling using statistical multiplayer games
- Multi-disciplinary SE
  - Interviews with stakeholders to understand interactions among disciplines with focus on assurance issues

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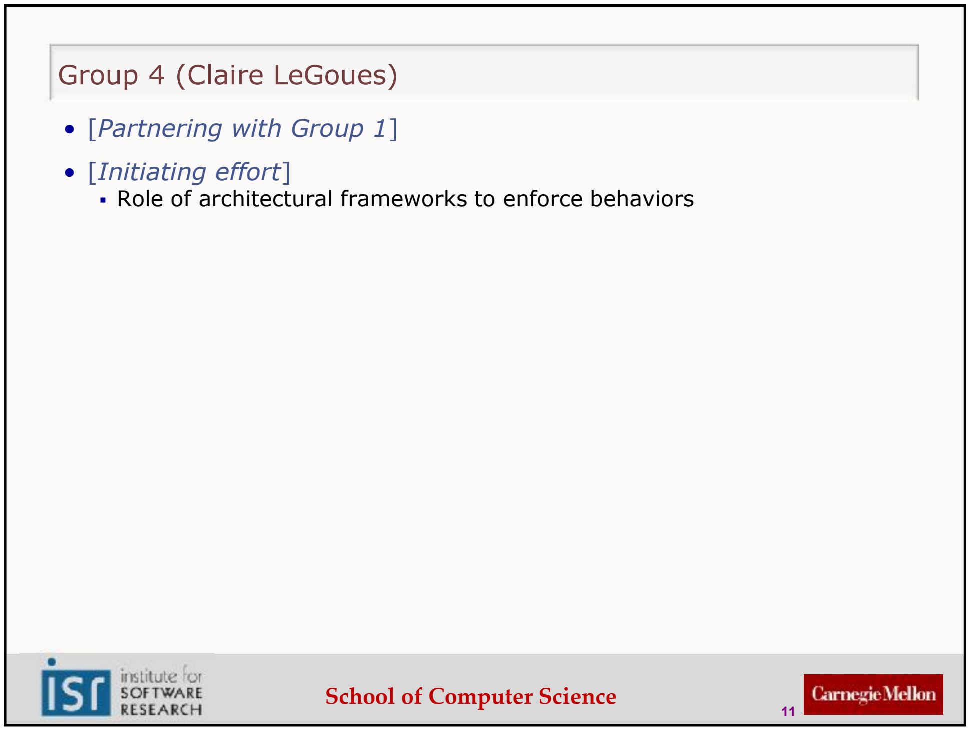

Group 4 (Claire LeGoues)

- [*Partnering with Group 1*]
- [*Initiating effort*]
  - Role of architectural frameworks to enforce behaviors

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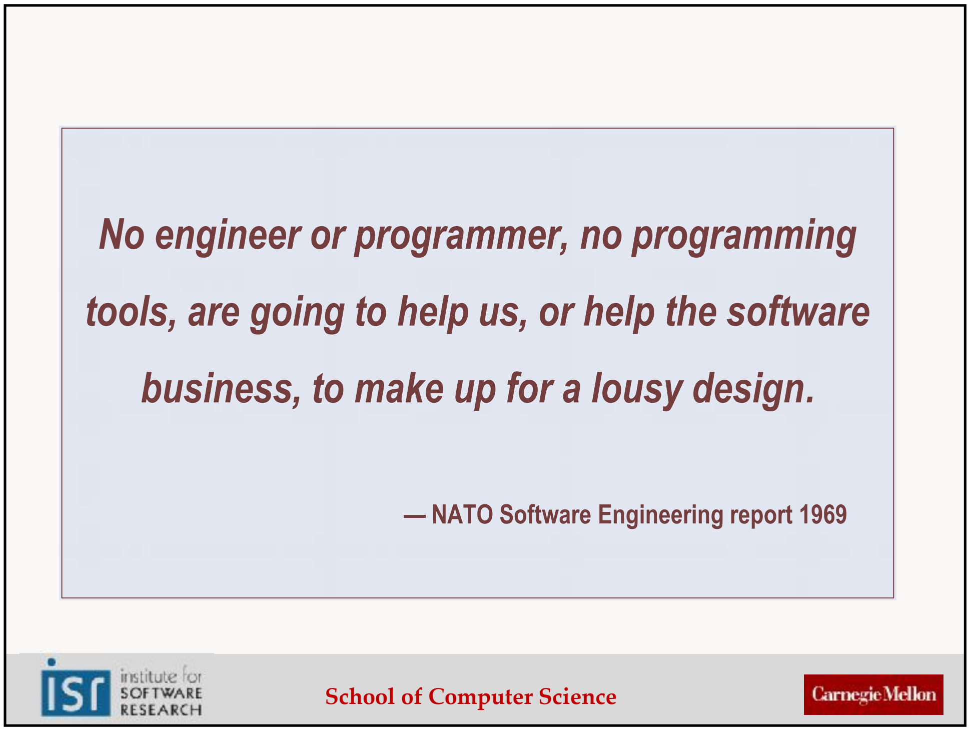

> ***No engineer or programmer, no programming tools, are going to help us, or help the software business, to make up for a lousy design.***
>
> **— NATO Software Engineering report 1969**

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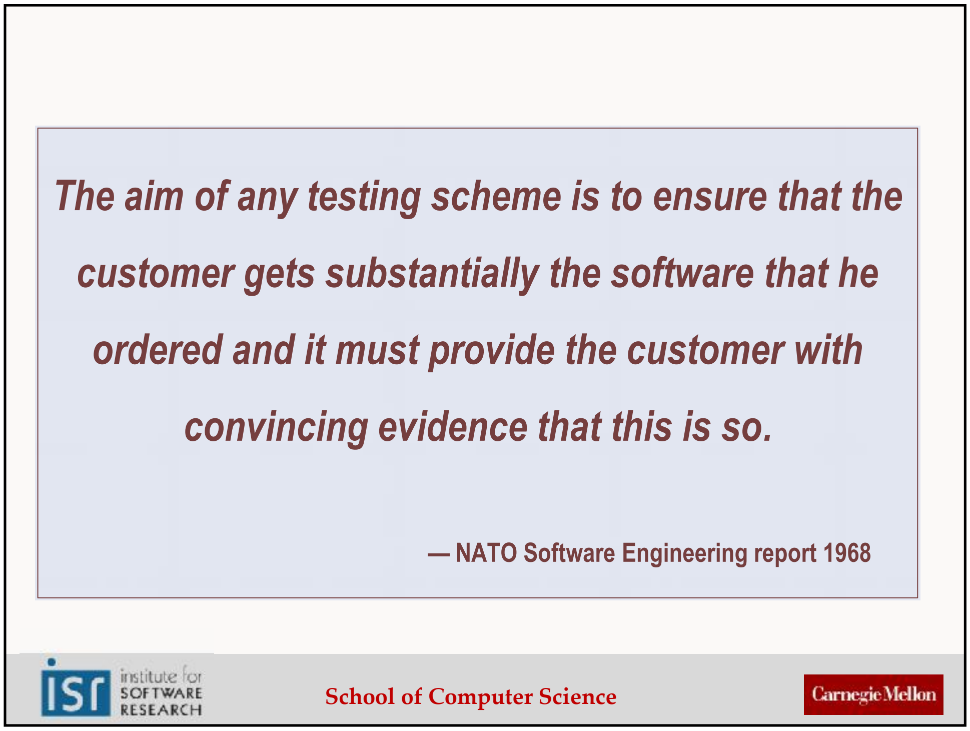

> *The aim of any testing scheme is to ensure that the customer gets substantially the software that he ordered and it must provide the customer with convincing evidence that this is so.*
>
> — NATO Software Engineering report 1968

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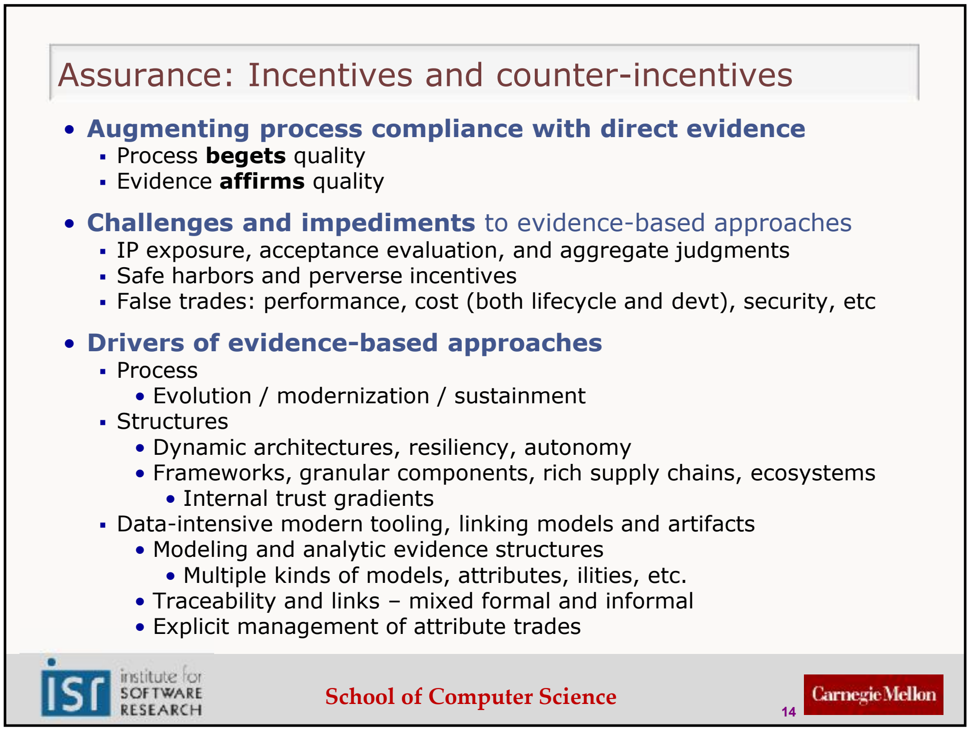

Assurance: Incentives and counter-incentives

- **Augmenting process compliance with direct evidence**
  - Process **begets** quality
  - Evidence **affirms** quality
- **Challenges and impediments** to evidence-based approaches
  - IP exposure, acceptance evaluation, and aggregate judgments
  - Safe harbors and perverse incentives
  - False trades: performance, cost (both lifecycle and devt), security, etc
- **Drivers of evidence-based approaches**
  - Process
    - Evolution / modernization / sustainment
  - Structures
    - Dynamic architectures, resiliency, autonomy
    - Frameworks, granular components, rich supply chains, ecosystems
      - Internal trust gradients
  - Data-intensive modern tooling, linking models and artifacts
    - Modeling and analytic evidence structures
      - Multiple kinds of models, attributes, ilities, etc.
    - Traceability and links – mixed formal and informal
    - Explicit management of attribute trades

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