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# Modeling Open Architecture and Evolutionary Acquisition in ARCI with Applications to RCIP

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## Defense Acquisition in Transition

6<sup>TH</sup> ANNUAL ACQUISITION RESEARCH SYMPOSIUM

# *Modeling Open Architecture and Evolutionary Acquisition in ARCI with Applications to RCIP*

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# Acquisition Challenges

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- **Fast evolution of threats and technologies** – often faster than acquisition programs
- **Need acquisition of systems that are integrated**
  - Across system mission (e.g. ISR, navigation)
  - Across platforms (carriers, destroyers, cruisers, etc.)
  - Across capability improvements (e.g. technology upgrades)
- **Need repeatable capability upgrade process**
- **Rapid Capability Insertion Process (RCIP)**
  - Conceptually designed ,
  - Needs better understanding of drivers of success for implementation



# Designing and Managing Fast-Evolving Acquisition

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- *Open Architecture (OA)*:
  - Modular design and design disclosure
  - Reusable application software
  - Interoperable joint warfighting applications and secure information exchange
  - Life cycle affordability
  - Encouraging competition and collaboration through development of alternative solutions and sources
- *Evolutionary Acquisition (EA)*:
  - Concurrent development phases
  - Only mature-enough technologies
- **But successful OA/EA programs have been episodic, not standard practice.**



# Research Questions

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**Q1:** How have OA and EA been successfully integrated for rapid capability insertion?

**Q2:** How can successful OA/EA processes and experiences be integrated into RCIP?



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# Research Approach

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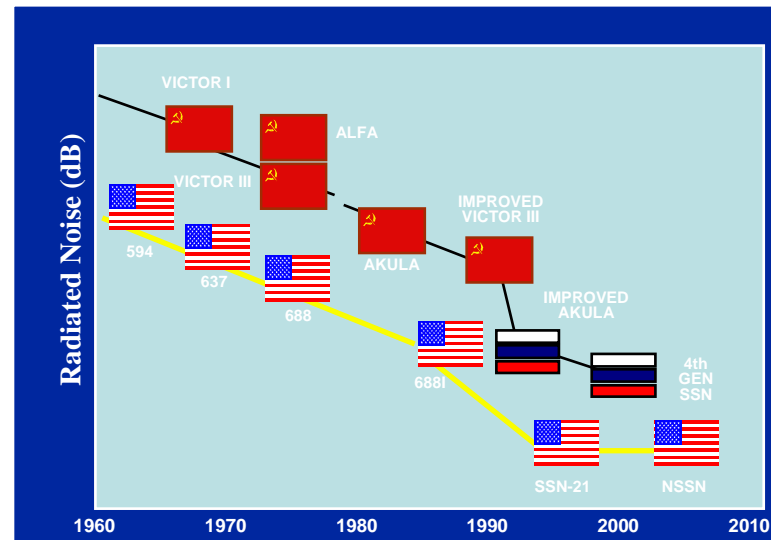
- 1) Build simulation model of successful rapid capability insertion process (ARCI program)
- 2) Change simulation model to better reflect RCIP
- 3) Simulate RCIP under variety of program characteristics and program environment conditions
- 4) Analyze results to better understand RCIP drivers



# The Acoustic Rapid COTS Insertion Program (ARCI) – Background (1 of 3)

- **Early 1990s:** Real and immediate reduction in submarine sonar advantage

## *FSU/US Nuclear Stealth*



From ARCI – A Historical Perspective, Mr. William Johnson, IWS 7.0  
Deputy Major Program Manager  
Future Combat Systems Open Architecture

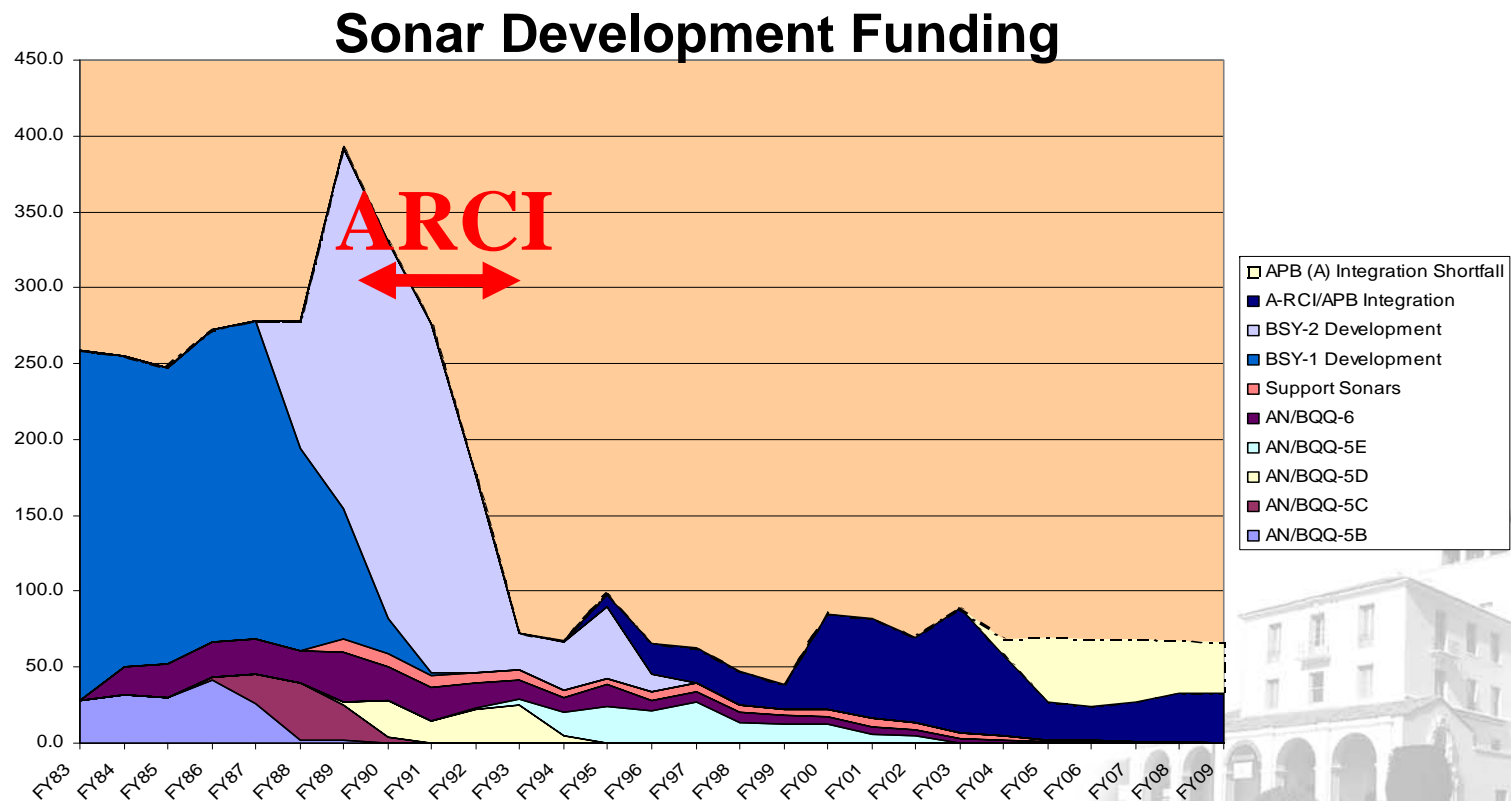
- Critical issue for the operating fleet – *needed improvement fast!*





# ARCI – Background (2of3)

- Sharp reduction in funding – “Build-new” not possible – *needed improvement cheap!*





# ARCI – Background (3of3)

- Legacy processors, software, and work stations were old (circa 1970s) and custom-built – expensive and slow to change – *needed a different acquisition process!*



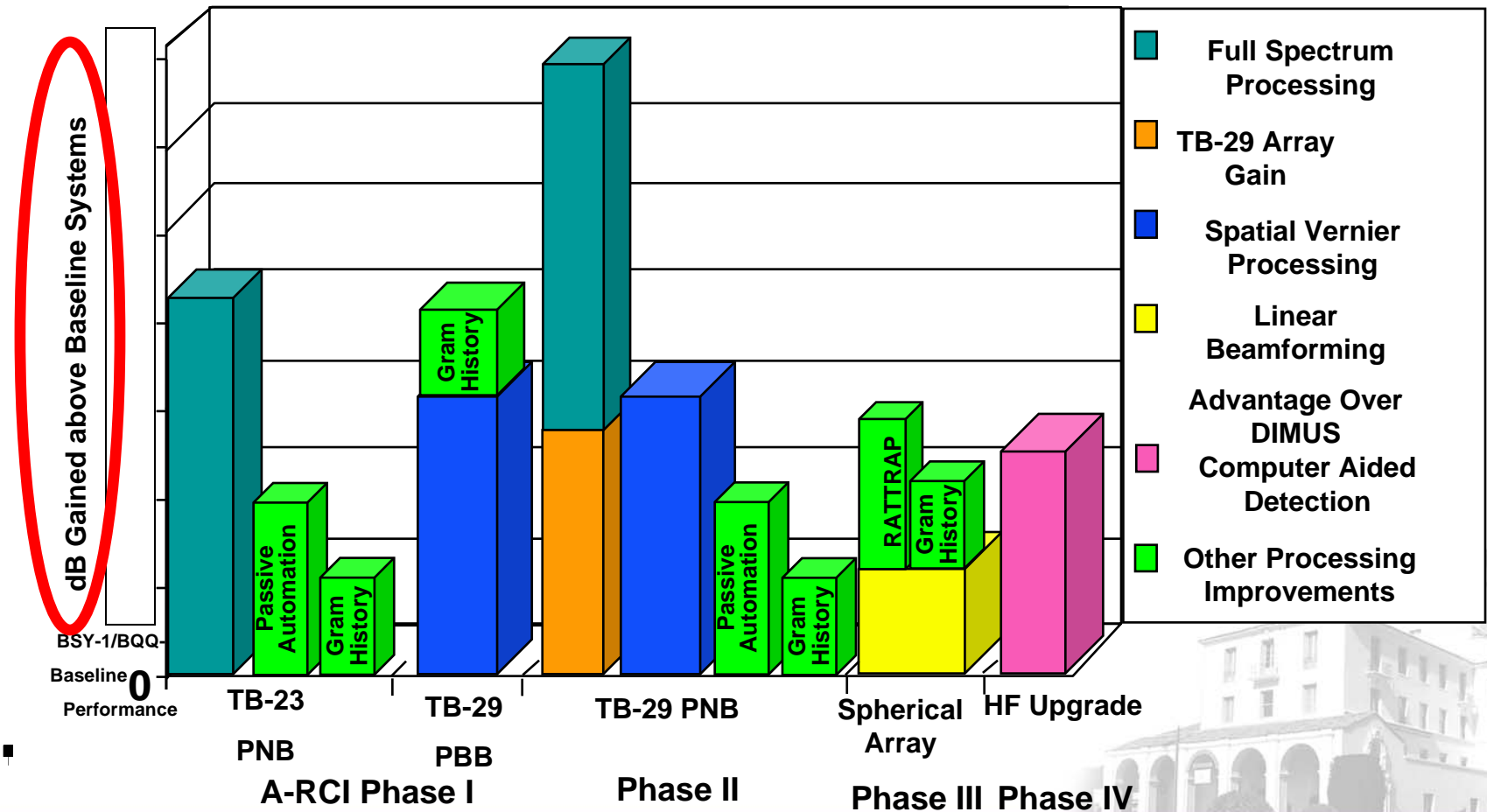
# ARCI – Program Performance (1 of 2)

- New upgrades (“builds”) every 12 months - *no schedule slippage*
- *Cost avoidance > \$3 billion*

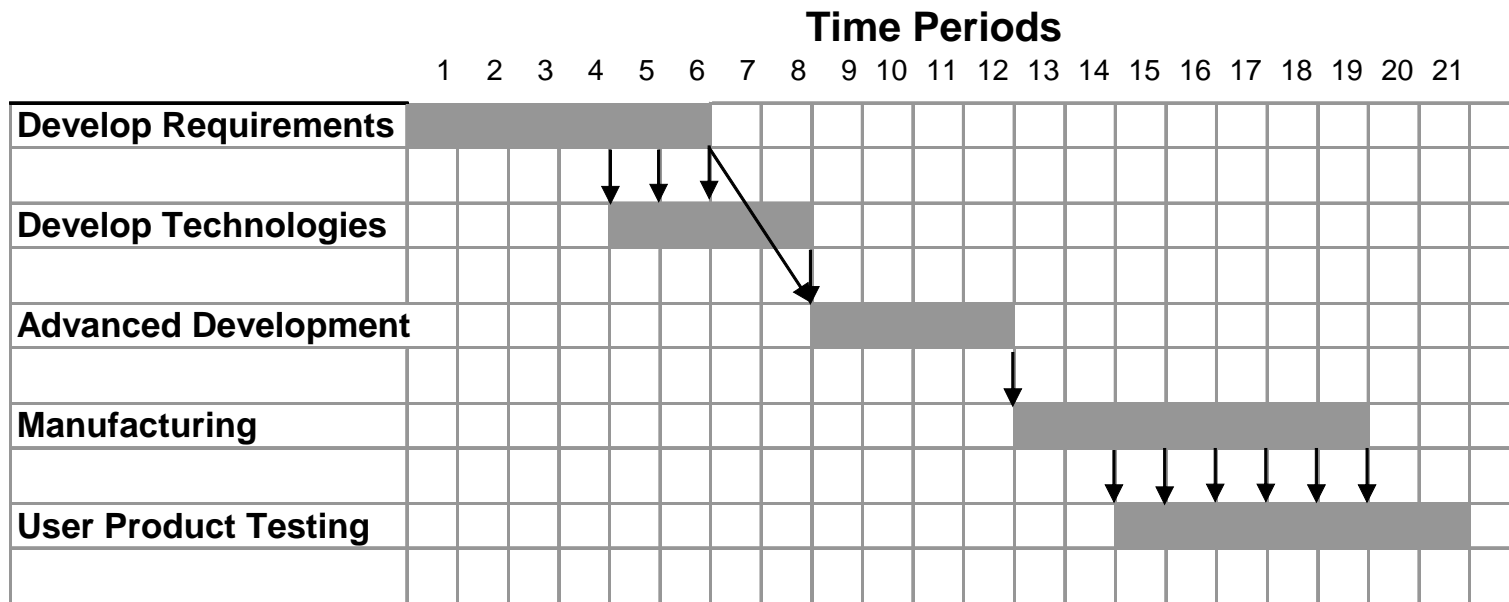


# ARCI – Program Performance (2of2)

- Sonar capability improvement



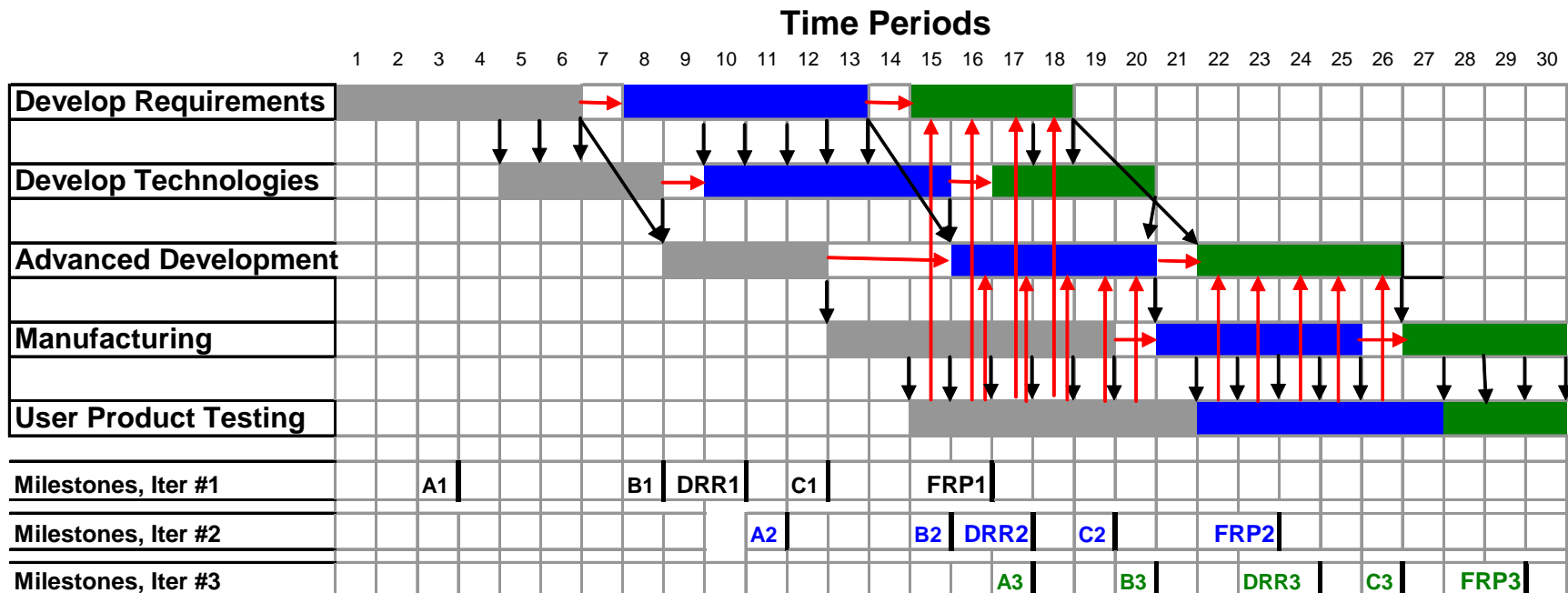
# Modeling ARCI: A Traditional Acquisition Process



Delays in developing requirements, technologies, or designs often delay deployment.



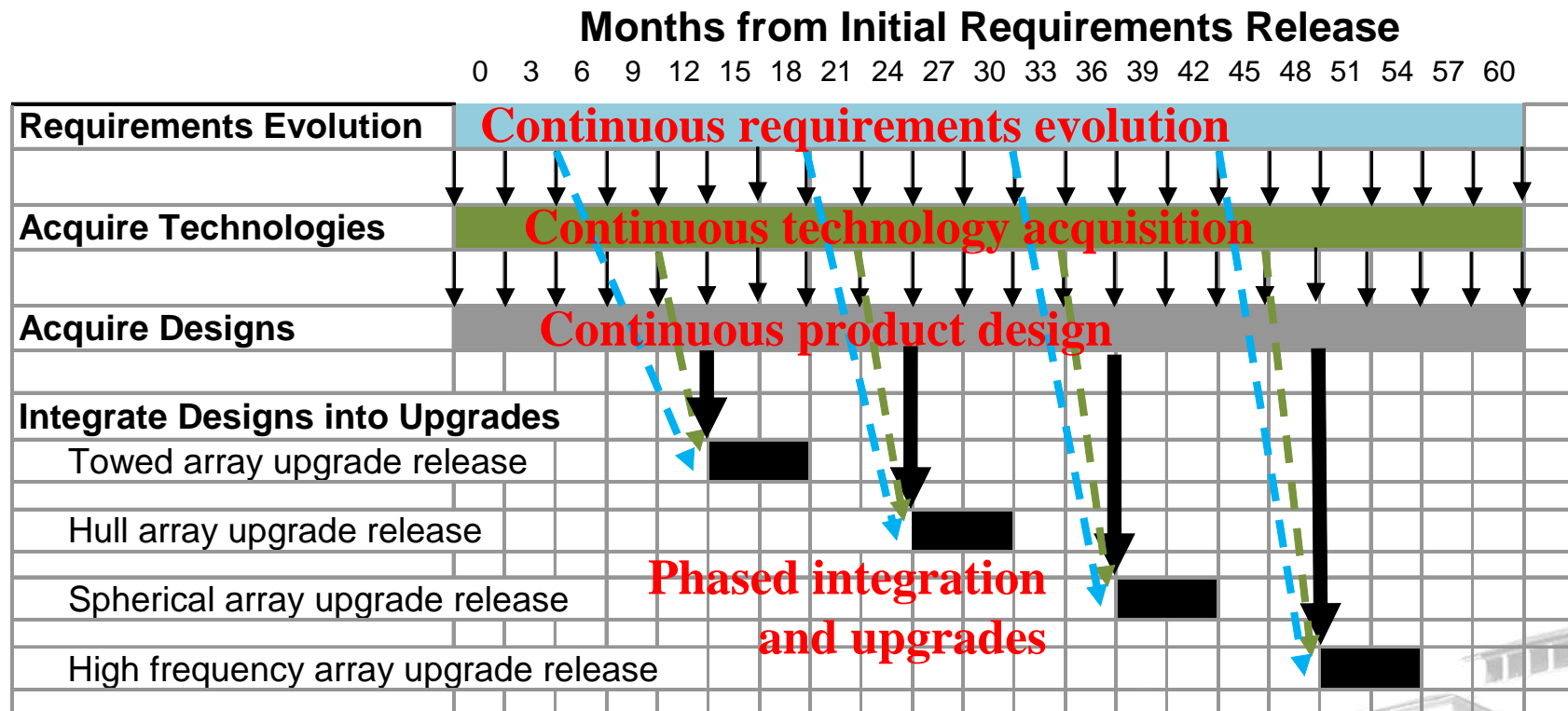
# Modeling ARCI: An Evolutionary Acquisition Process



- **Revised EA project model to reflect some important characteristics of Open Architecture (OA):** modularity, standards management, reduced component design, etc.



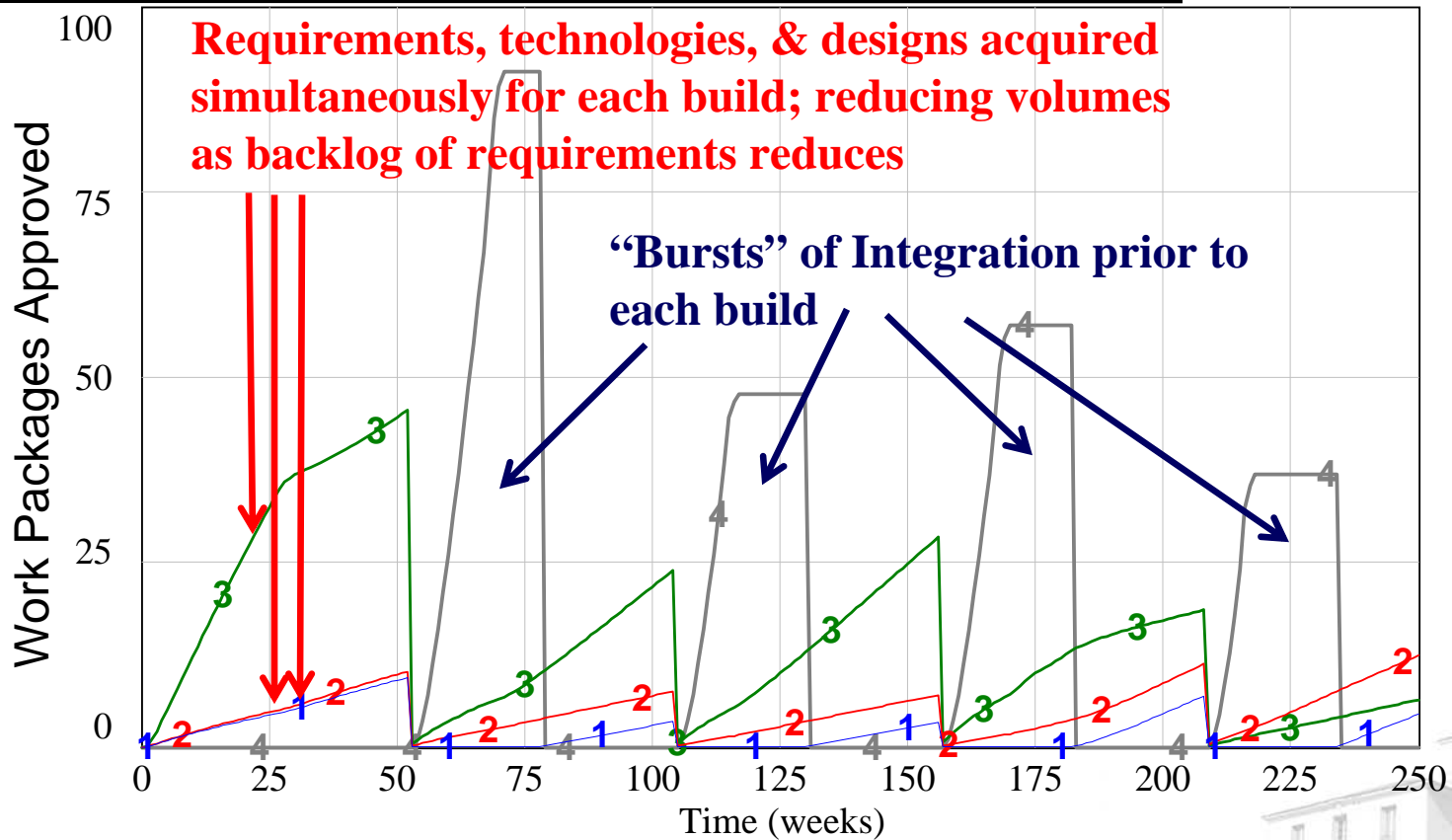
# Modeling ARCI: The ARCI Acquisition Process



- Select mature-only requirements, technologies, and designs at beginning of Integration
- **Delay solutions to next upgrade to not delay build if required**



# ARCI – Simulation Results



Work Approved[Requirements,Iter1] : ARCI 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4  
 Work Approved[Technology,Iter1] : ARCI 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4  
 Work Approved[Design,Iter1] : ARCI 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4  
 Integration work approved : ARCI 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4

**Approved Requirements, Technologies, Design & Integration**



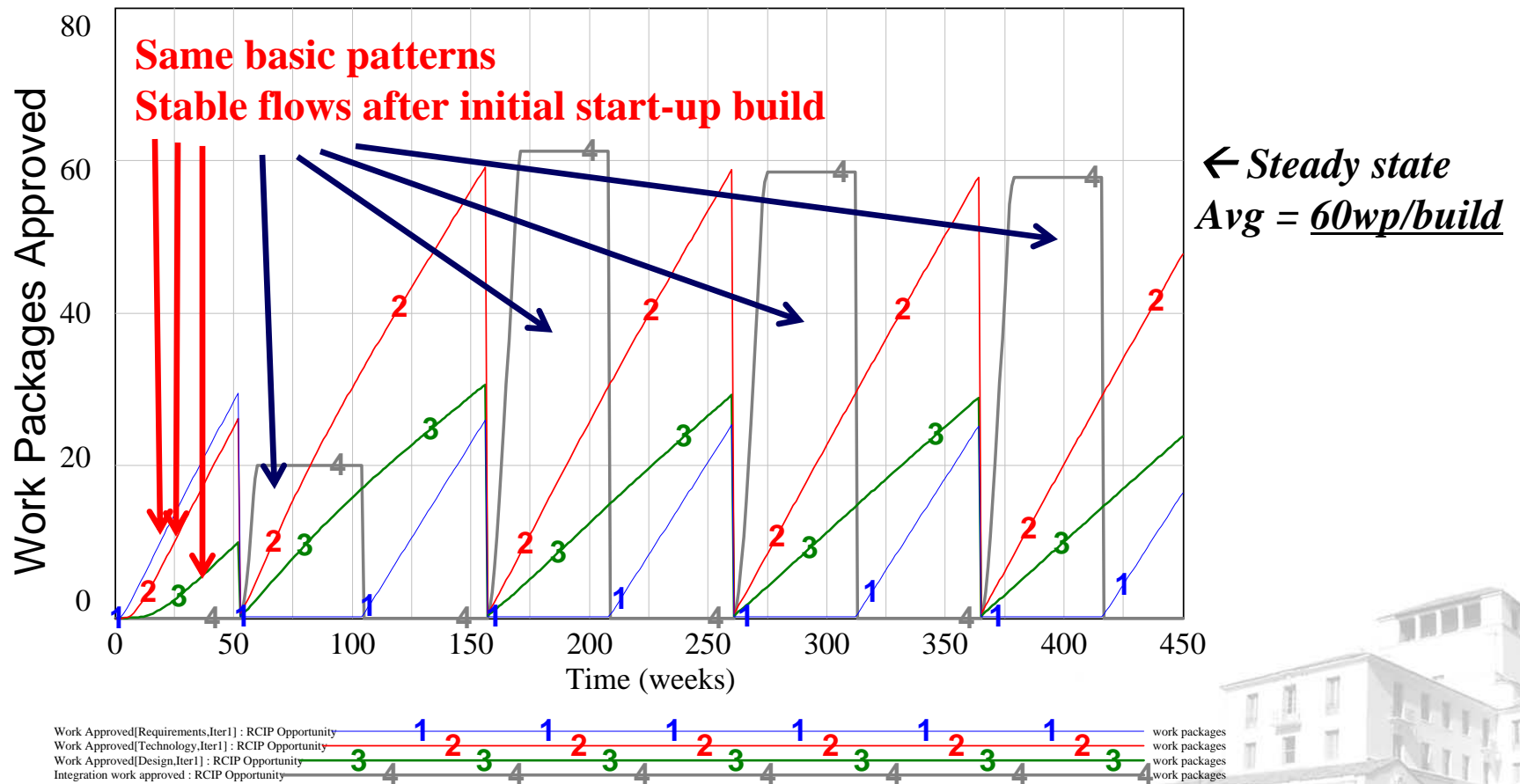


# Revising the Model to Reflect the Rapid Capability Insertion Process (RCIP)

- Increase scope to reflect larger programs
- Continuous inflow of new requirements
- No existing inventory of requirements in steady state
- Reduced inventory of off-the-shelf solutions
- Capability upgrades every 2 years (vs. yearly)
- Integration phase duration = 12 months (vs. 6 months)



# RCIP – Opportunities for Improved Performance



## Approved Requirements, Technologies, Design & Integration



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# ARCI to RCIP – Implementation Challenges

<u>Acquisition Program Feature</u>	<u>Phased Program with OA &amp; EA</u>	<u>ARCI Program</u>	<u>RCIP Programs (vs. ARCI)</u>
<b>Development processes</b> (Requirements, Technologies, Advanced Development)	Repeated separate phases	Primarily continuous processes, <i>known requirements</i>	<i><u>Continuous inflow of requirements</u></i>
<b>Innovation sources</b>	Primarily through Prime contractor	<i>Primarily Off-the-shelf solutions</i>	<i><u>Mix of new development &amp; off-the-shelf.</u></i>
<b>Product System Modularity</b>	Often integrated across phases & development blocks	<i>Primarily separate systems</i> (towed, hull, spherical, high frequency)	<i><u>More systems &amp; system interactions. More inter – system integration required</u></i>
<b>Govt./Supplier Relationships</b>	Prime contractor	“Prime” coordinator & multiple solution suppliers	<i><u>Larger solution supplier pool</u></i>
<b>Primary Locus of Performance Flexibility</b>	Cost, Schedule	Scope	<i><u>Scope with possible flexibility in cost</u></i>



# RCIP Implementation Challenges – Changes to the Simulation Model

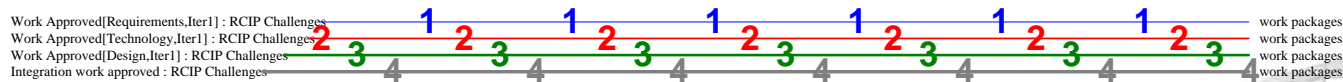
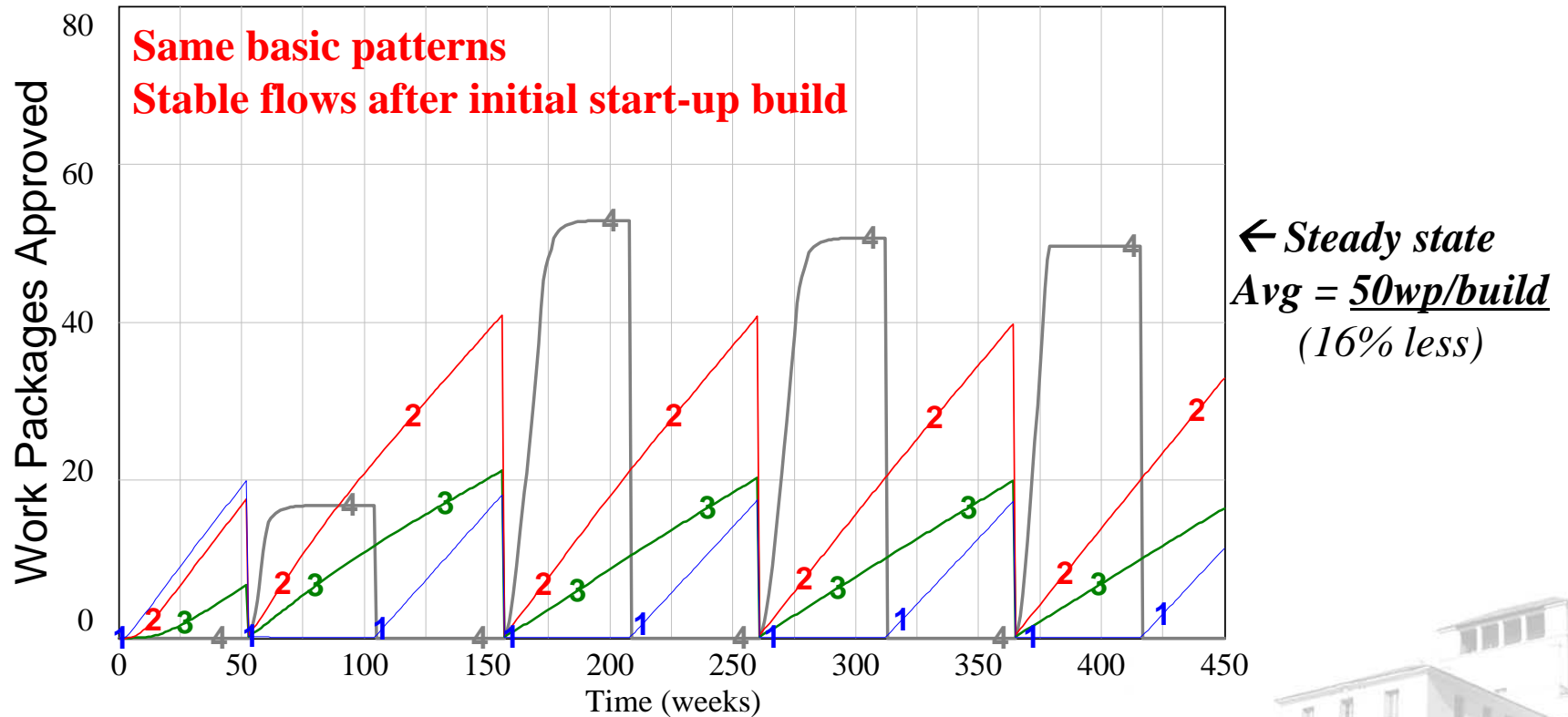
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- **Increase scope → more oversight**
  - Reduced productivity on larger scope (reduced 20%)
- **No existing inventory of requirements** (steady state)
- **Reduced inventory of off-the-shelf solutions**
  - Reduce techn. & Adv Dev initially developed (50%)
  - Increased iteration in integration phases (increased 25%)
- **Increased integration required**
  - More integration scope (increased 25%/solution)



# RCIP Implementation Challenges

## Simulation Model Results



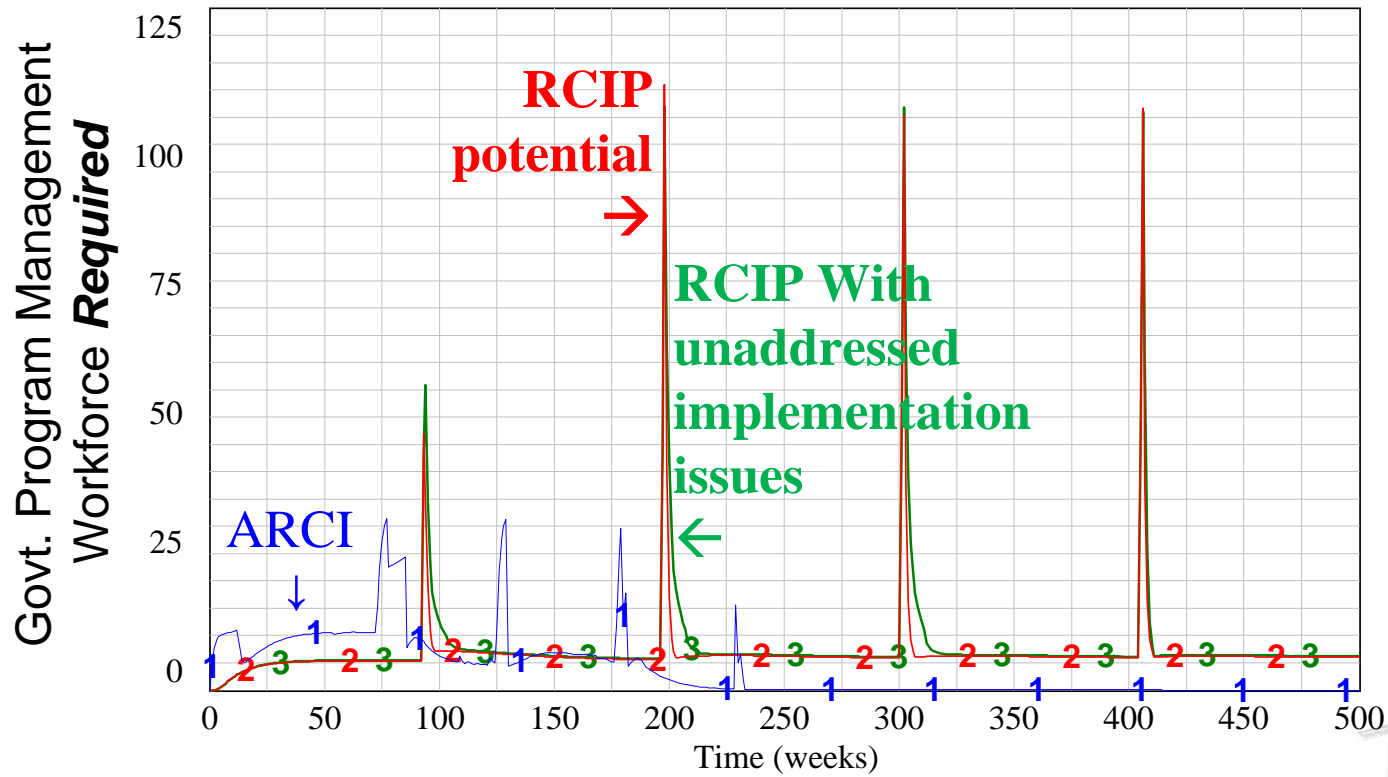
**Approved Requirements, Technologies, Design & Integration**



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# RCIP Implementation Challenges – The Burnout Challenge



RCIP will require significantly more Government Program Management resources due to “bursts” of integration work.





# Implications for Practice

## Addressing RCIP Implementation Challenges

<u>Acquisition Feature</u>	<u>ARCI Program</u>	<u>RCIP Programs</u> (vs. ARCI)	<u>RCIP Implementation Risk Management</u>
<b>Development processes</b>	Primarily continuous processes, known requirements	Continuous processes with <i>continuous inflow of requirements</i>	<i><u>1) Standardize continuous processes</u></i> <i><u>2) Add rigor for sustainability</u></i>
<b>Innovation sources</b>	Primarily Off-the-shelf solutions	<i>Mix of new development &amp; off-the-shelf.</i> More new development	<i><u>1) Adapt continuous processes to mix of off-the-shelf/new development solutions</u></i> <i><u>2) Use “only - mature - enough” strategy</u></i>
<b>Product System Modularity</b>	Primarily separate systems (towed, hull, spherical, high frequency)	More systems and system interactions. <i>More inter – system integration required</i>	<i><u>Operationalize modular configuration management for large scale acquisition with focus on integration</u></i>
<b>Government / Supplier Relationships</b>	“Prime” coordinator & multiple solution suppliers	<i>Larger solution supplier pool</i>	<i><u>Formalize open, transparent, objective, &amp; repetitive competition processes and organizations</u></i>
<b>Primary Locus of Performance Flexibility</b>	Scope	Scope with possible flexibility in cost	<i><u>Improve user - acquisition coordination to make RCIP responsive to warfighter priorities</u></i>





# More Implications for Practice

## Designing RCIP Implementation

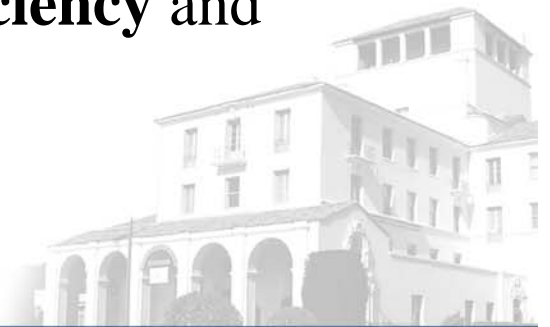
- **Improved integrated organization/process design and description**
  - Frequent solution competitions, closer user-acquisition coordination,
  - As operational as possible
- **New supplier roles**
  - Former “prime” in coordinator-only role, not solution supplier
  - Many and diverse solution suppliers
- **New Government Program Management skills**
  - Dynamic management of requirements selection and solution acquisition (balance flexibility of scope, schedule, cost)
  - Leveraging of existing solutions (e.g. software libraries) (OA)
  - Open competition among many solution suppliers (OA)



# Conclusions

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- **ARCI has demonstrated the potential** to radically improve acquisition performance in continuous-upgrade programs
- Implementing ARCI lessons into RCIP for broader use requires the **further development of new acquisition processes, changes in supplier roles, and development of different program management skills**
- Successfully implementing RCIP can **greatly improve acquisition program effectiveness and efficiency** and provide a basis for widespread adoption.





# Questions? Comments? Discussion?

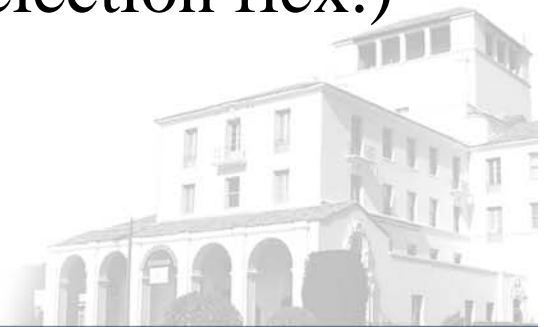


# Analysis of the ARCI Program

## Atypical Program Environment

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- **Fleet need for fast capability improvement**
  - Extensive and direct involvement by warfighters
  - Strong support by fleet upon demonstration of improvement
- **Very limited funding**
  - Encouraged use of COTS (enormous savings)
- **Many available off-the-shelf technologies & designs**
  - Encouraged use of COTS (provided selection flex.)
- **Era of acquisition reform**
  - Reduced oversight



# Analysis of the ARCI Program

## Atypical Program Design Features

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- **Fixed and frequent capability improvements**
  - Facilitated delaying requirement fulfillment until mature
- **Extensive use of developed technologies & designs**
  - Added capacity & capabilities developed since original development
  - Added flexibility for future upgrades and meeting extra-COTS requirements
  - Many suppliers: ONR, academia, small businesses
- **Extensive replacement of legacy systems with COTS**
  - Inherently modular – accelerated upgrades
- **Continuous warfighter involvement in acquisition**
  - Improved development due to realistic operations input to acquisition
  - Provided typically-unavailable operations data for testing and development
  - Built fleet support through participation





# Analysis of the ARCI Program

## Atypical Program Management

- **Redesigned supplier relations and processes**
  - Prime contractor in coordinator role only – not supplier
  - Repeated open competitions (& objective solution evaluations)
- **Maturity was the basis for upgrade scope**
  - “Pull” resource allocation based on needs vs. “Push” of requirements
  - Identify and select mature solutions at start of integration
- **Continuous requirements development, technology development, and design**
  - Not tightly linked to program schedule
  - Upgrade content decisions & commitments late vs. early



# ARCI's Atypical Objectives – A Notional Model

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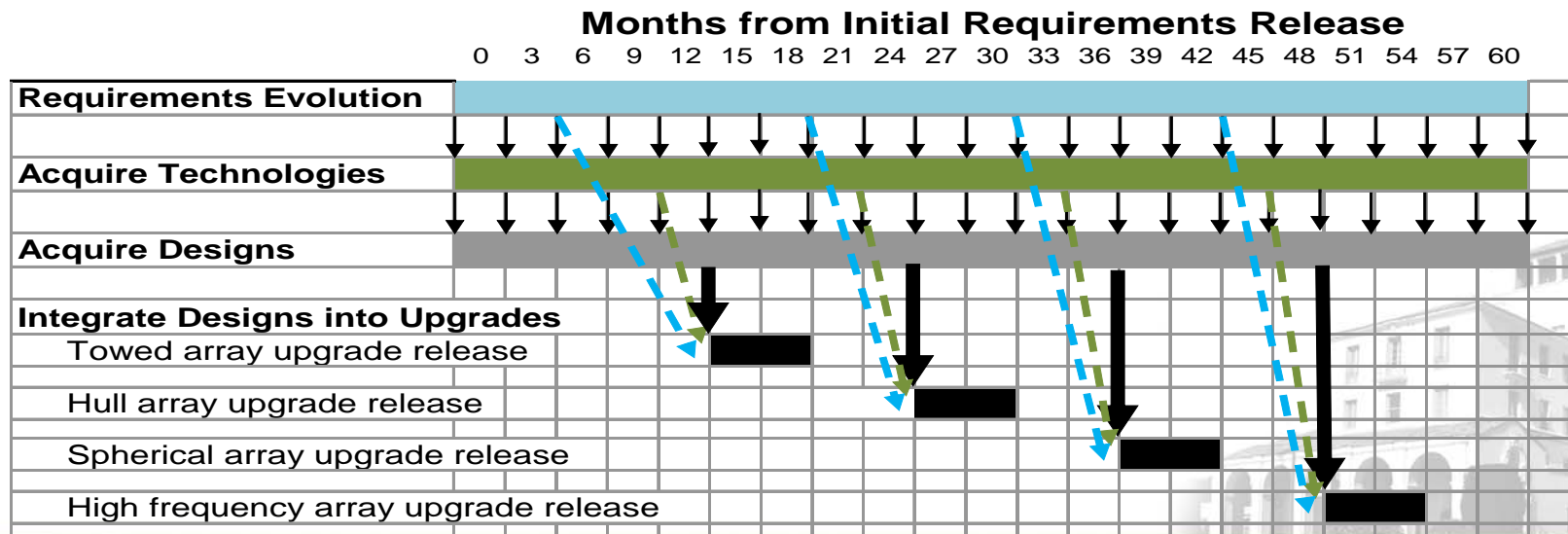
- *When resources constrain progress, what performance dimension is most flexible?*  
Ranking from least flexible to most flexible...
- **Traditional programs:**
  - 1.% Requirements filled
  2. Cost
  3. Schedule
- **ARCI:**
  1. Schedule (no delaying of builds)
  2. Cost
  - 3.% Requirements filled (in this build)





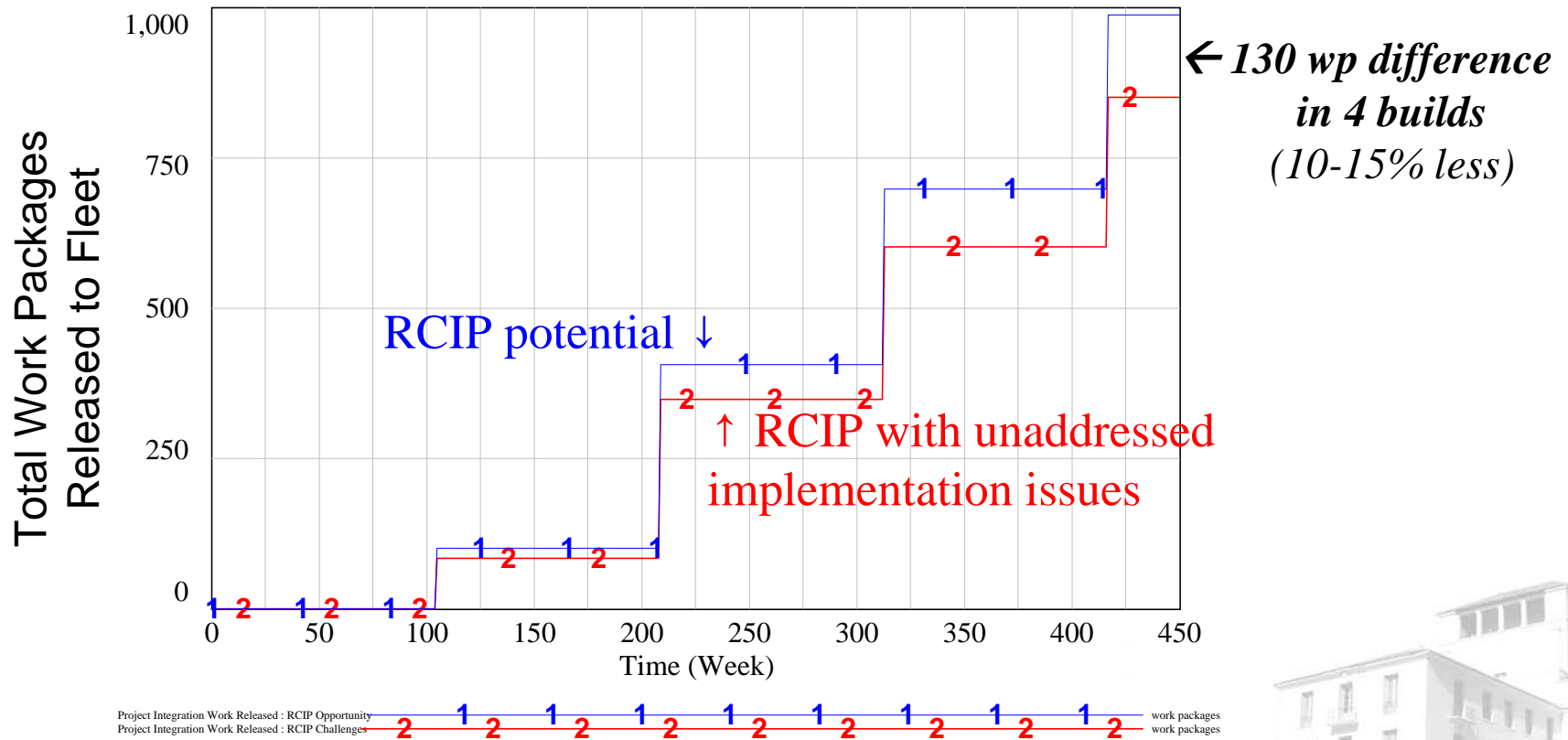
# A Simulation Model of ARCI

- ARCI acquisition process
- Six resource types
  - Technology acquisition, design, integration
  - Program management (govt.) and suppliers



# RCIP Implementation Challenges

## Implications for Design and Practice



### Cumulative RCIP Performance without and with Implementation Issues

