Simulation of Kanban-based scheduling for SoS

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System of Systems

- Acknowledged and directed SoS:

- Three main levels:
  - Executive/Stakeholder management
  - System Engineering team
  - Product/Domain teams

- Example: Health care SoS (next slide)
Overview of KSS Network

Executive/Stakeholder Management
- Strategic planning
- Capability prioritization

System Engineering
- Analyze needs and capabilities
- Refine Capabilities
- Develop requirements
- Allocate requirements
- Form cross organization / cross disciplinary teams.
- Cross product and specialty engineering

Product/Domain Engineering

User Support
- Customer relations
- Initial triage

User Support Kanban board
- TO DO:
  - B6: Wrong data in DB
  - B7: IU bug in...
- WIP:
  - B4: Wrong date reported
- DONE:
  - B1: Wrong midnight time format

Domain team

Patient Management System
- Product SE
- Identify SW features
- Decompose requirements into features
- Allocate features to SW development teams
- Features integration

Patient Management System Kanban board
- TO DO:
  - T4: ...
  - T5: ...
- WIP:
  - T2: ...
  - T3: ...
  - T6: ...
- DONE:
  - T1: ...

Domain team

SW Development Team
- SW task development

SW Development Team Kanban board
- TO DO:
  - T6: ...
  - T5: ...
- WIP:
  - T4: ...
  - T3: ...
  - T2: ...
- DONE:
  - T1: ...

Domain team

Database Domain

Database Domain Kanban board
- TO DO:
  - T4: ...
  - T5: ...
- WIP:
  - T2: ...
  - T3: ...
  - T6: ...
- DONE:
  - T1: ...

Domain team

Network Domain

Network Domain Kanban board
- TO DO:
  - T4: ...
  - T5: ...
- WIP:
  - T2: ...
  - T3: ...
  - T6: ...
- DONE:
  - T1: ...

Domain team

Work Flow
System of Systems’ observed issues

- Lack of visibility
- Inefficient use of resources
- Time wasted on context switching
- Valuable capabilities are not delivered first
  - value delivery cadence is not satisfactory
  - stakeholders cannot effectively update priorities when values change
Example 1

- 10 teams (20 members each) + system engineering team.
- 20 new capabilities at start.
- Each capability unfolds into 30 requirements on average
- Each requirement unfolds into 9 tasks on average.
- Each tasks takes 3-15 days.
- There are 5 expedite tasks that cause blocked work (blocked tasks)
Example 1: value comparison

Value

Time

KSS

Value-neutral (random selection)

LIFO
Example 1: number of suspended tasks

Number of Suspended Tasks

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<th>Time</th>
<th>Value-neutral (random selection)</th>
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Example 2: work items in progress

![Graph showing WIP over time with lines for KSS, Value-neutral (random selection), and LIFO.]
Example 1: total time spent (schedule)

Total schedule (days)

- KSS: 61 days
- Value-neutral (random selection): 70 days
- LIFO: 68 days
Example 1: total effort

Total effort (person-days)

- **KSS**: Effort required if there are no interruptions
- **Value-neutral (random selection)**
- **LIFO**
Example 1: context switching

Effort on context switching (person-days)

- KSS
- Value-neutral (random selection)
- LIFO
Example 2

- 15 teams (12 members each) + system engineering team.
- 10 new capabilities at start
- 20 more capabilities added during the simulation
- Each capability unfolds into 30 requirements on average
- Each requirement unfolds into 10 tasks on average.
- Each task takes 3-15 days.
- There are 10 expedite tasks that cause blocked work (blocked tasks)
- Simulation time-frame: 1 hour
- Simulation length (fixed time simulation): 200 days/1600 hours.
Example 2: even more complex scenario
Example 2: capability completeness

Number of 100% complete capabilities

<table>
<thead>
<tr>
<th>Method</th>
<th>Number of 100% complete capabilities</th>
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<td>KSS</td>
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<td>LIFO</td>
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Conclusion: future work

- Pilot the Kanban scheduling with several organizations
- Fine-tune the simulator using empirical data and organizations’ feedback
- Scale up the cases we run through the simulator
- Refine and calibrate cost models
References


