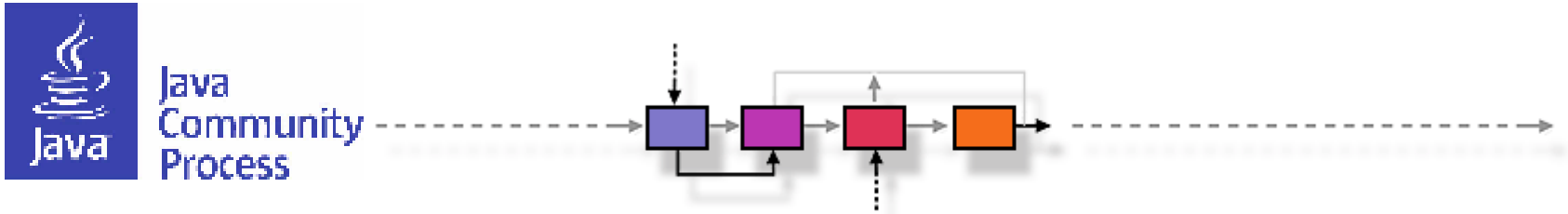
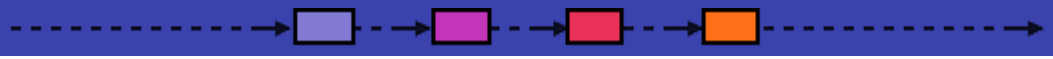



# JSR 302 Review
# Safety-Critical Java

January 13, 2014

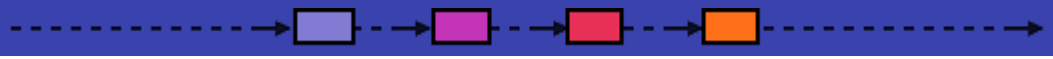
Doug Locke, Ph.D. (Specification Lead)
The Open Group

# Agenda



- Goals
- Information to be gathered
  - Background
  - Technical Scope
  - Expert Group
  - Deliverables: Specification, RI, TCK, IP
  - Schedule
  - Publicity, Collaboration, Participation, and Transparency
- Implementation notes
- Issues
- Questions, discussion, next steps

# Background – What is a Safety-Critical System?



- What is a Safety-Critical System (SCS)?
  - Any system that MUST have an extreme level of reliability
  - An SCS failure may result in loss of life or property
  - An SCS is subject to formal certification (e.g., DO-178C)
  - Formal certification is very expensive (ca $40-50/SLOC)

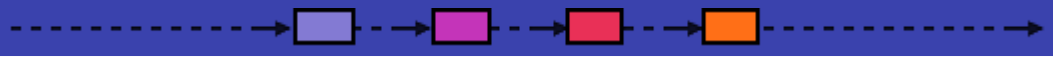
# Background – History of SCSs

- Originally, SCSs were rare, small, and simple
  - E.g, aircraft autopilot (ca 1975)
  - SCSs now found in increasing numbers and complexity
    - Aircraft, spacecraft, air traffic control, automotive, rapid transit, medical devices, power generation and transmission, industrial controls, military vehicles, UAVs, weapons, etc.
  - Until about 1980, all SCSs written in Assembly
  - 1980 – 1995, most SCSs written in C
  - 1995 – present, subset of Ada used (Ravenscar profile or SPARK)
  - No dynamic memory allocation in SCSs until recently
  - No OO SCSs until 2012

# Background – JSR-302

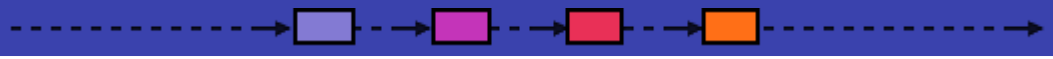
- SCSs represent a new technology domain for Java
  - Application code must be as simple as possible
  - Certification required for both application and infrastructure
  - Almost all SCSs have “hard real-time” characteristics
  - Provably correct memory management is critical
- Around 2004, The Open Group (TOG) started a High Assurance Software initiative
  - TOG is a consortium of about 400 companies, government agencies, and other consortia
  - Members wanted a modern, robust language for use in such S/W
  - Therefore, TOG started an effort for Safety-Critical Java
  - JSR-302 was approved in 2006.

# Business/Marketing/Ecosystem Justification



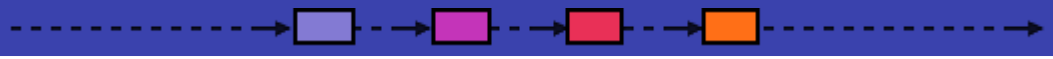
- Why do this JSR?
  - Permit SCSs to exploit major Java strengths for safety, reliability, portability
- What's the need?
  - Existing SCSs are overly expensive, and difficult to certify
  - They tend to duplicate infrastructure capabilities (e.g., drivers, memory management, scheduling)
- How does it fit in to the Java ecosystem?
  - Built upon RTSJ (JSR-1, JSR-282) to maintain compliance with J2ME and J2EE – currently requires Java 7.
- Is the idea ready for standardization?
  - Yes. Multiple organizations in TOG are looking for this.

# Expert Group



- The EG consists of the following members:
  - Industrial: aicas, IBM, Atego, Boeing, Rockwell Collins, Siemens, DDC-I
  - Academic: Andy Wellings, Martin Schoeberl, Anders Ravn
  - Others: Ben Brosgol, Scott Anderson, Joyce Tokar
- The EG currently meets weekly by teleconference
- The EG communicates internally with e-mail, and via an SVN repository

# Brief Technical Overview (1)



- Introduces three Compliance Levels (Level Zero, One, and Two)
  - Higher levels permit more complex applications
  - Higher levels require more expensive infrastructure
- Introduces Mission concept
  - Application consists of one or more Missions
  - Missions can be sequenced arbitrarily
  - At Level Two, multiple Missions are possible simultaneously
- Mission consists of
  - Non-GC memory area
  - One or more Schedulable Objects (from RTSJ)
- RTSJ-subset memory management (e.g., can't share private memory across Schedulable Objects)

# Brief Technical Overview (2)

- Simple I/O using JME Connectors and Connections
  - No file management)
- Supports RTSJ Interrupt Service Routines
- Supports RTSJ Raw Memory (e.g., DMA, memory-mapped I/O)
- Supports RTSJ Clocks and Timers, including user-defined clocks
- Simple JNI support
  - Limited reflection
  - Specification defines supported JNI interfaces
- Exception support is subset of RTSJ

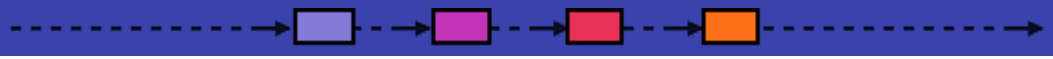
# Brief Technical Overview (3)

- Specific Java SCJ Annotations are required
  - E.g., SCJAllowed(level) means that a method is allowed for an SCJ application at Level “level” or below, and that it is executable on any SCJ infrastructure supporting Level “level” or above.
- Specification defines all SCJ-supported Java library classes and methods from
  - java.io
  - java.lang
  - java.microedition.io
  - javax.realtime
  - javax.realtime.device
  - javax.safetycritical
  - javax.safetycritical.annotate
  - javax.safetycritical.io

# History

- Initial work on SCJ started in The Open Group in 2003
- JSR-302 was approved in July 2006
- First Early Draft Review started 7 January, 2011
  - Completed 7 April, 2011
- Second Early Draft Review started 28 June, 2013
  - Completed 26 September, 2013
- Besides EDR releases, the EG has released many drafts via TOG meetings and academic postings.
  - E.g., https://github.com/scj-devel/doc which is maintained by researchers at the Technical University of Denmark

# Other Deliverables

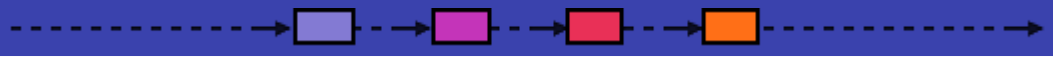


- Other than the Specification, RI, and TCK, the EG does not currently plan other deliverables
- However, the SCJ Specification (currently at 344 pages not counting Javadoc Appendices) provides
  - Detailed semantics descriptions
  - Computational model descriptions
  - Sample application code
  - Rationale for key capabilities and limitations

# Publicity

- Open Group Real-Time and Embedded Forum
  - regular updates presented
  - E.g., http://www.opengroup.org/sanfrancisco2014/rtes
- Java Technology for Real-time and Embedded Systems (JTRES)
  - Annual conference dedicated to RTSJ and SCJ issues
  - Has met every year since 2003
  - More than 100 papers published and presented on SCJ topics
  - See jtres2014.compute.dtu.dk/ for 2014 Niagara Falls conference information

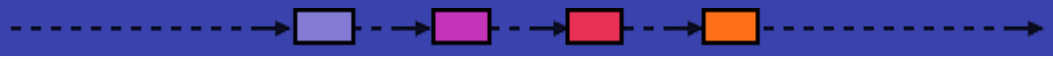
# Collaboration with other community groups



- We are collaborating with JSR-282 to ensure maximal compatibility between the specifications.
  - Issues forwarded to JSR-282 EG
  - JSR-282 updates then returned to the EG
  - Accommodations regularly made to ensure that SCJ is implementable on an RTSJ base
- Three EG members are also JSR-282 members
- We also collaborate with the Open Group Realtime and Embedded Forum.

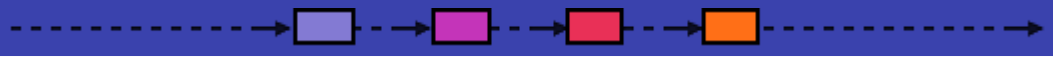
Java Community Process

# Implementations



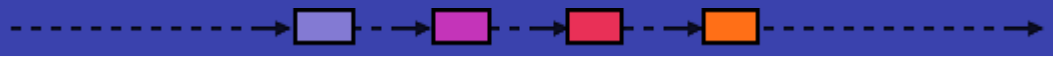
- The RI is being developed by aicas, GmbH
- An SCJ implementation is currently available from
  - Aalborg University and VIA University College, Denmark
  - http://www.icelab.dk/index.html
- Another SCJ implementation is being created at the Technical University of Denmark
  - http://cj4es.imm.dtu.dk/

# Schedule



| Milestone | Date |
| --- | --- |
| Specification Draft Complete | 1 Mar. 2015 |
| Final Draft Review Start | 1 Apr. 2015 |
| First RI Release | 1 May. 2015 |
| First TCK Release | 1 Jun. 2015 |

# IP flow



- The SCJ Specification uses an open license:
  - https://www.jcp.org/aboutJava/communityprocess/licenses/jsr302/JSR-302SpecificationLicense.txt
- The SCJ RI and TCK use an open source license:
  - https://www.jcp.org/aboutJava/communityprocess/licenses/jsr302/302RILicense.txt
- We have received a number of comments and contributions from outside the JCP. The EG reviews all contributions and incorporates them when possible.
- All collaboration tools are open source
- We do not currently have a contributor agreement
- We are not aware of any legal concerns

Java Community Process

# RI and TCK development

- The JSR-302 RI is being developed by aicas GmbH
- The JSR-302 TCK is being developed by Aalborg University and VIA University College, Denmark (from SCJ formal semantics)
- Neither of these are from the spec-lead organization.
- The RI and TCK will be available for public download
- We plan to provide a public source code repository for the RI and TCK
  - We will plan for this before completion of JSR-302

# Participation and transparency

- JSR-302 is managed by The Open Group
  - TOG manages many open standards
  - E.g., TOG manages the POSIX standard
- The JCP page is https://www.jcp.org/en/jsr/detail?id=302
- The SCJ project website is http://douglocke.com/SCJ

# Adopt-a-JSR

- This is a new requirement that we have not been tracking.
- What do we have to do?

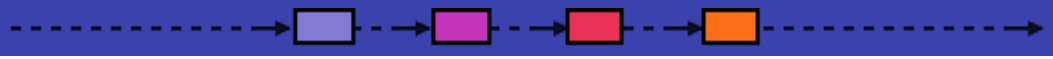
# Mailing lists or forums

- This is a new capability for us
- Twitter hashtag: #SCJava
- Spec lead has tweeted several messages on SCJ
- We expect increased message traffic as we near completion
- Pointers to twitter and project website added to SCJ-302 page on jcp.org as well as in twitter messages.
- JTRES community regularly updated on SCJ progress

# Issue tracker

- This project is nearly complete
- The project started with 17 major issues
- All major issues have been closed
- At present, 8 minor issues are open, expected to be closed in January
- On average ca 12 issues opened and closed each month.
- Spec Lead keeps issues list, sends to EG list regularly
- Non-EG issues become EG issues immediately, are then reported back to originator by Spec Lead

# Document archive



- Public documents consist of public presentations and draft specifications
  - Presentations made at TOG meetings quarterly
  - Draft specifications published on GitHub
  - GitHub also used by community researchers
- Private repository (SVN) used for EG document archives
  - Specification using LaTex, with Javadoc tools
  - Any EG member can build the spec

# Other transparency and participation metrics

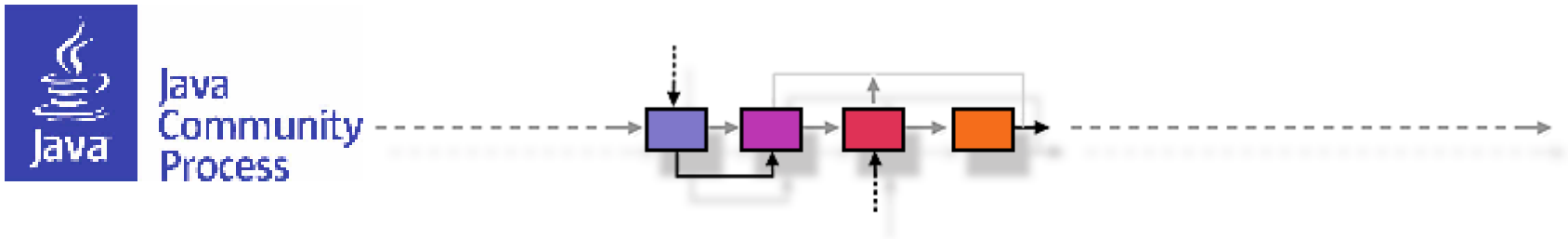
- The Safety-Critical Java community is an active subset of the real-time Java community
- This community consists of practitioners and researchers involved in safety-critical and Java technology
- There have been over 100 papers published on SCJ

# Implementation notes

- Methodologies for creating certifiable infrastructures for safety-critical systems are known
  - Very expensive
  - Each mechanism must be certifiably correct
  - Large number of documented “artifacts” must be created for certification
  - Both implementation and application must be certifiable
  - Rigorous development methodologies and testing must be followed

Questions, discussion, next steps

Java Community Process




Thank you!

http://jcp.org