Systems Engineering (SE) Project Metrics

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Need of SE Metrics

- Why do we need SE Metrics?
  - Determine how the projects are doing in regards to cost, schedule and performance
    - Provide feedback to projects
  - Determine the usefulness of SE Organizational Standard Processes (OSP)
    - Continuous improvement of current OSPs
- At the end of the day:
  - Want to help projects become more successful

Metrics

- Perform data collection and analysis for the following metrics on a quarterly basis and generate reports including recommendations

- List of Metrics:
  1. Requirements Stability
  2. Quality of Requirements
  3. Requirements Traceability
  4. Procedure Compliance
  5. Customer Satisfaction
  6. Process Tailoring
  7. Technical Performance Measures (TPMs)
  8. Project Deliverables
  9. Execution Per Roadmap
  10. Technical Reviews

Metrics

- Discuss the following metrics today:

  - **Requirements Stability**
  - **Quality of Requirements**
  - **Requirements Traceability**
  - **Procedure Compliance**
  - **Project Deliverables**
  - **Execution Per Roadmap**

Requirements Stability

Purpose

- Ensure projects are properly defining their requirements
- Ensure projects are not excessively modifying requirements after they have been reviewed and baselined
- Extreme fluctuations late in the program can indicate poor requirement development or management
- Show requirements trends over time on projects

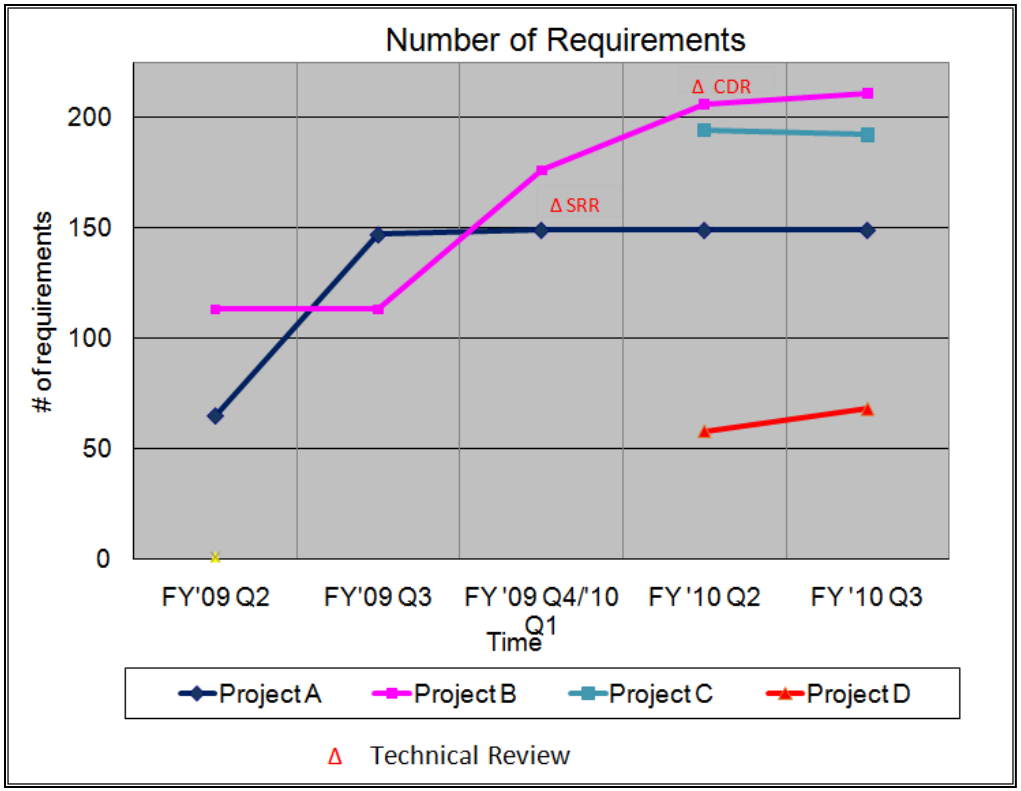
Collection Method

- Request SE leads to provide their requirements

Calculation Method

- Count the # of requirements
  - New requirements
  - Deleted requirements
  - Total Requirements

Requirements Stability Charts



Project Name	Total Number of Requirements				
	FY'09 Q2	FY'09 Q3	FY '09 Q4/'10 Q1	FY '10 Q2	FY '10 Q3
Project A	65	147	149	149	149
Project B	113	113	176	206	211
Project C				194	192
Project D				58	68

Project requirements stabilize over time

Findings & Actions

- Findings:
  - Requirements stability is critical to project success

- Actions:
  - Projects are now required to show requirements stability charts at all technical reviews after the FY'09 Q3

Quality of Requirements

Purpose

- Ensure that project requirements are being written in an acceptable manner
- Poorly written requirements is an early indication of issues

Collection Method

- Request SE leads to provide access to their requirements

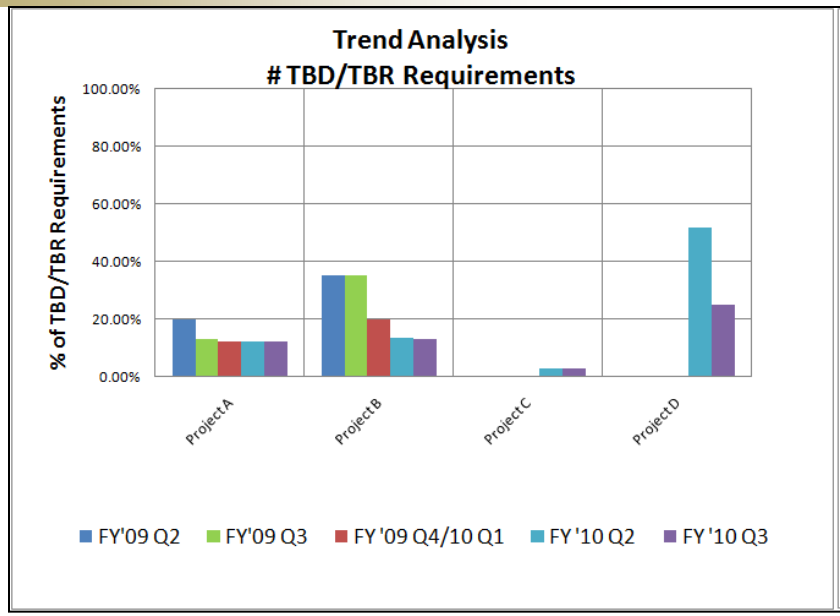
Calculation Method

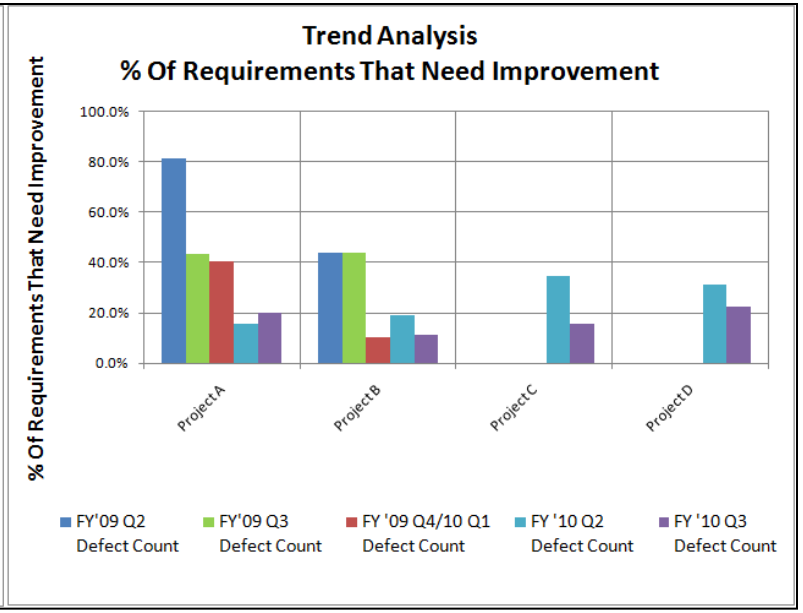
- Check the requirements for the following defect categories:

Achievable	Necessary and Sufficient	Expressed in terms of needs, not solutions	Complete
Verifiable	Consistent		Unambiguous

- Manually search a sample size of requirements [10-25% of total] to determine defects
- Count the number of To Be Determined (TBD)s, To Be Reviewed (TBR)s requirements

Quality of Requirements Charts





Analysis:

% of TBDs/TBRs are acceptable since these projects are still defining their requirements

Project A :12% - Same # from Q2'10 to Q3'10
Project B :14% - Same # from Q2'10 to Q3'10
Project C :3% - Same # from Q2'10 to Q3'10
Project D : 29% - **Decreased** from Q2'10 to Q3'10

Review 10~20% sample size of the Project requirements

Project A 6/30 –(20%) for Q3'10. (16%) for Q2'10)
Project B 6/54 – (11%) for Q3'10. (19%) for Q2'10)
Project C 5/32 – (16%) for Q3'10. (34%) for Q2'10
Project D 6/27 – (22%) for Q3'10. (31%) for Q2'10

Malcolm Baldrige National Quality Award 2007 Award Recipient

Note: Projects are techbase so TBD/TBR is expected as the requirements are still evolving and some projects are still defining requirements.

Findings & Actions

- Findings:
  - Requirements were not well written and inconsistencies exists between projects
  - Tech base projects are expected to have some TBDs/TBRs
  - Positive Trend Observed
    - Quality of requirements have improved
    - TBDs/TBRs have decreased

- Actions:
  - Corrective actions were taken immediately such as:
    - Developed a Requirements Development best practices guide which includes characteristics of a quality requirement to write good requirements
      - ✓ Incorporated into the OSP
      - ✓ Trained the workforce
  - Feedback was provided to projects

Requirements Traceability

Purpose

- Ensure that all requirements are traced from higher to lower level and vice versa

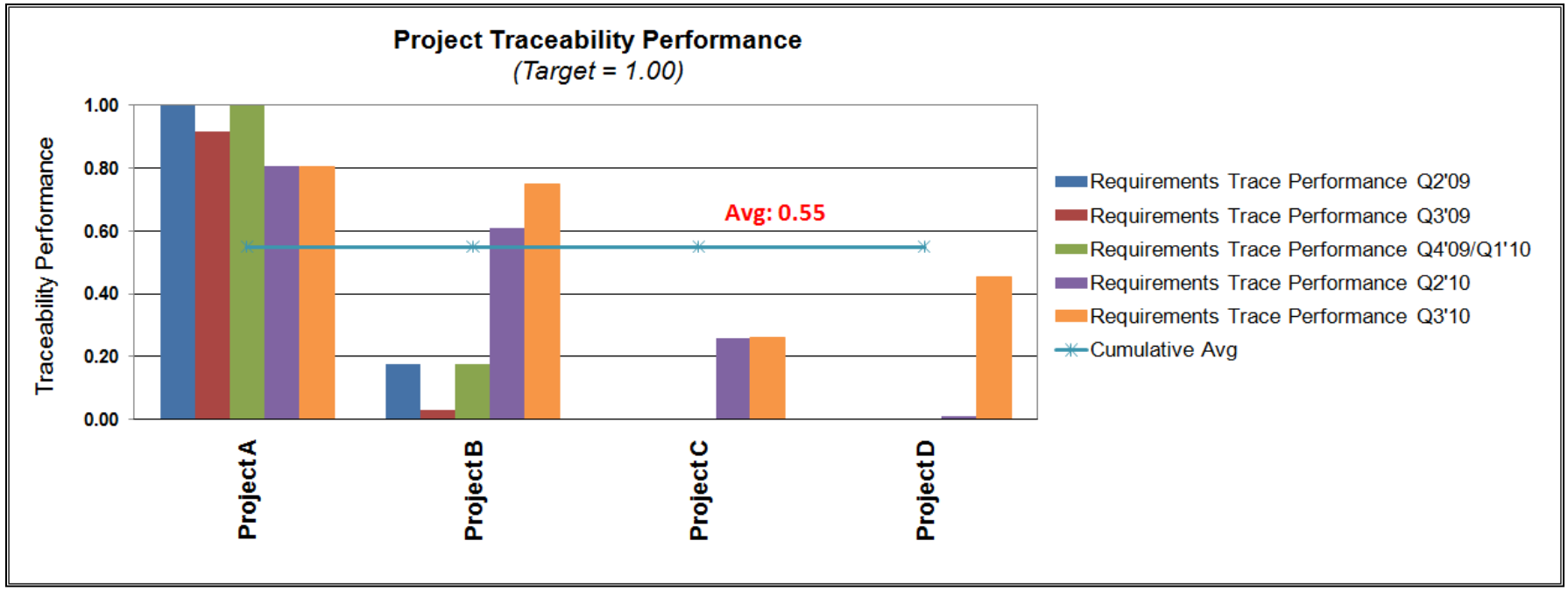
Collection Method

- Request SE leads to provide access to their requirements management tool (DOORS)

Calculation Method

- Conduct traceability analysis in the requirements management tool (DOORS)

Requirements Traceability Charts



Analysis:

- Overall Traceability has increased from Q2'10 to Q3'10.(42% to 57%)
- Project A has decreased traceability. It is an issue and was reported to the management.
- Project B and Project D (0 % to 46%) has increased traceability from Q2'10 to Q3'10

Findings & Actions

- Findings:
  - Requirements were not 100% traced from higher to lower level and vice versa
- Actions:
  - Provided guidance on using DOORS Tool for requirements.
  - Projects have improved on traceability once DOORS tool have been used
  - Keep encouraging project leads to put more effort into tracing their requirements
  - Ran reports in DOORS to check for In-links and Out-Links to verify traceability
  - Suggested and provided the traceability guidance document to use

Procedure Compliance

Purpose

- Ensure the procedures are followed as tailored by the project:
  - Requirement Management (RM)
  - Requirement Development (RD)
  - Configuration Management (CM)
  - Data Management (DM)
  - Technical Assessment (TA)

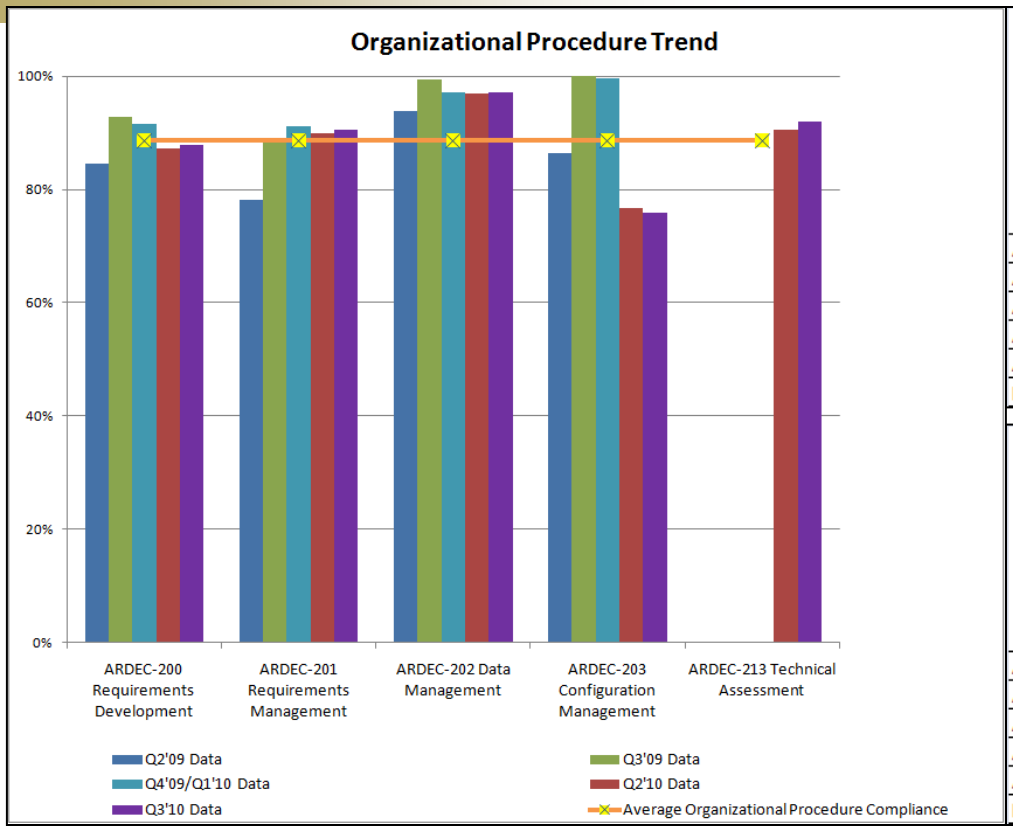
Collection Method

- Face to Face sessions with SE

Calculation Method

- Accept SE's input for compliance
- Two way communications with the SE to assess compliance
- Compliance is also verified with documentation

Procedure Compliance Charts



Project Procedure ComplianceQ3'10	Project A	Project B	Project C	Project D	Organizational Procedure Compliance
ARDEC-200 Requirements Development	97.92%	94.79%	87.50%	71.30%	87.88%
ARDEC-201 Requirements Management	100.00%	100.00%	98.33%	63.54%	90.47%
ARDEC-202 Data Management	98.13%	100.00%	100.00%	90.63%	97.19%
ARDEC-203 Configuration Management	80.00%	100.00%	71.00%	52.50%	75.88%
ARDEC-213 Technical Assessment	100.00%	100.00%	86.88%	80.83%	91.93%
Project Process Compliance	95.2%	99.0%	88.7%	71.8%	88.67%

Project Procedure ComplianceQ2'10	Project A	Project B	Project C	Project D	Organizational Procedure Compliance
ARDEC-200 Requirements Development	97.92%	93.75%	90.00%	67.71%	87.34%
ARDEC-201 Requirements Management	100.00%	100.00%	92.81%	66.67%	89.87%
ARDEC-202 Data Management	100.00%	100.00%	100.00%	87.50%	96.88%
ARDEC-203 Configuration Management	80.00%	100.00%	68.33%	58.33%	76.67%
ARDEC-213 Technical Assessment	100.00%	100.00%	80.91%	80.91%	90.45%
Project Process Compliance	95.6%	98.8%	86.4%	72.2%	88.24%

Analysis:

- Average Procedure compliance has almost stayed the same from Q2’10 to Q3’10. (88.24% to 88.67%)

Findings & Actions

- Findings:
  - None of the projects were 100% compliance with their project's processes
  - Early indication that some of the standard OSPs are not used efficiently

- Actions:
  - Provided Peer Review procedure, Technical Assessment procedure and Lessons Learned procedure to the project SE.
    - Reminded that the SE OSPs are available at the Process Assess Library (PAL)
  - Provided guidance on how to do Configuration Management Audits
  - Reviewed which OSPs may be required to be modified based on data collected
    - Some sections may not be required

Project Deliverables

Purpose

- Determine the “goodness” of SE deliverables

Collection Method

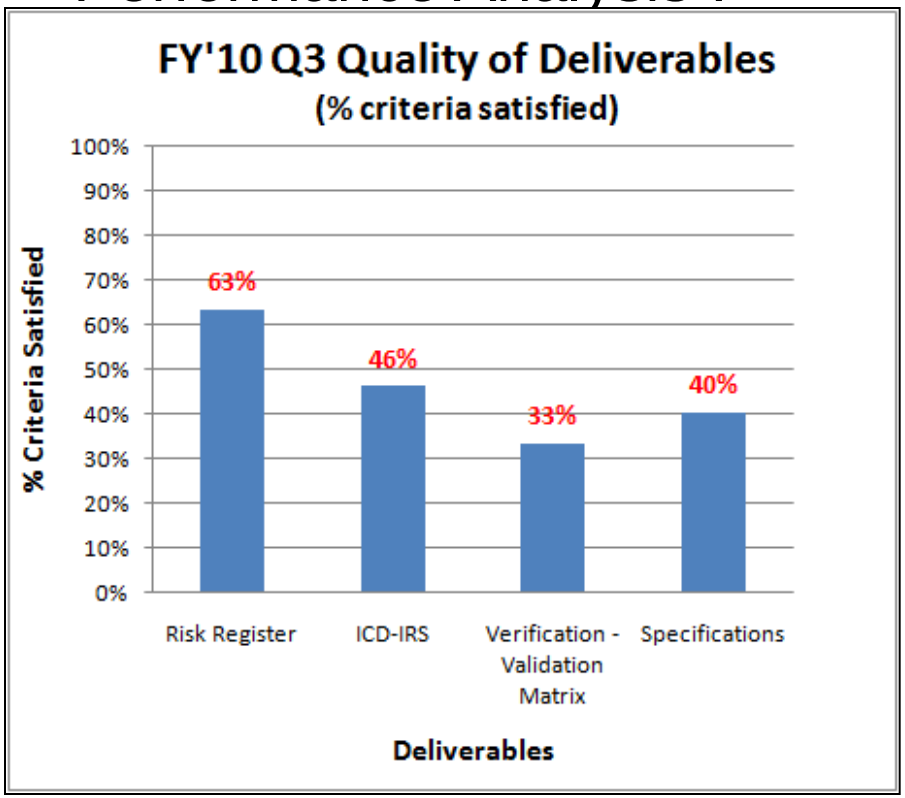
- Request project leads to provide deliverable

Calculation Method

- Independent Review based on pre established criteria checklist specific per deliverable
- Provided the pre-established criteria checklist to the projects

Project Deliverables Charts

Performance Analysis :



	Project A	Project B	Project C	Project D	Artifacts Reviewed	Criteria Satisfied
Risk Register	1		1	1	3	63%
ICD-IRS		1	1		2	46%
Verification - Validation Matrix				1	1	33%
Specifications			1		1	40%

Projects have partially satisfied the criteria of good deliverable

Findings & Actions

- Findings:
  - Project deliverable are not meeting the pre-established criteria of a good deliverable

- Actions:
  - Provided guidance documents on how to develop risk register, ICDs, Verification matrix to improve the quality of the current deliverables
    - ICD – provided the ICD template
    - Verification-validation matrix – provided an example
    - Specification – provided the requirements specification template
    - Risk Register – provided the Risk Register template

Execution Per Roadmap

Purpose

- Determine the project's SE task performance index (TPI)
- Find out if planned tasks are being accomplished according to the project roadmap schedule
- Ensure that all planned tasks get completed according to the schedule (TPI=1)

Collection Method

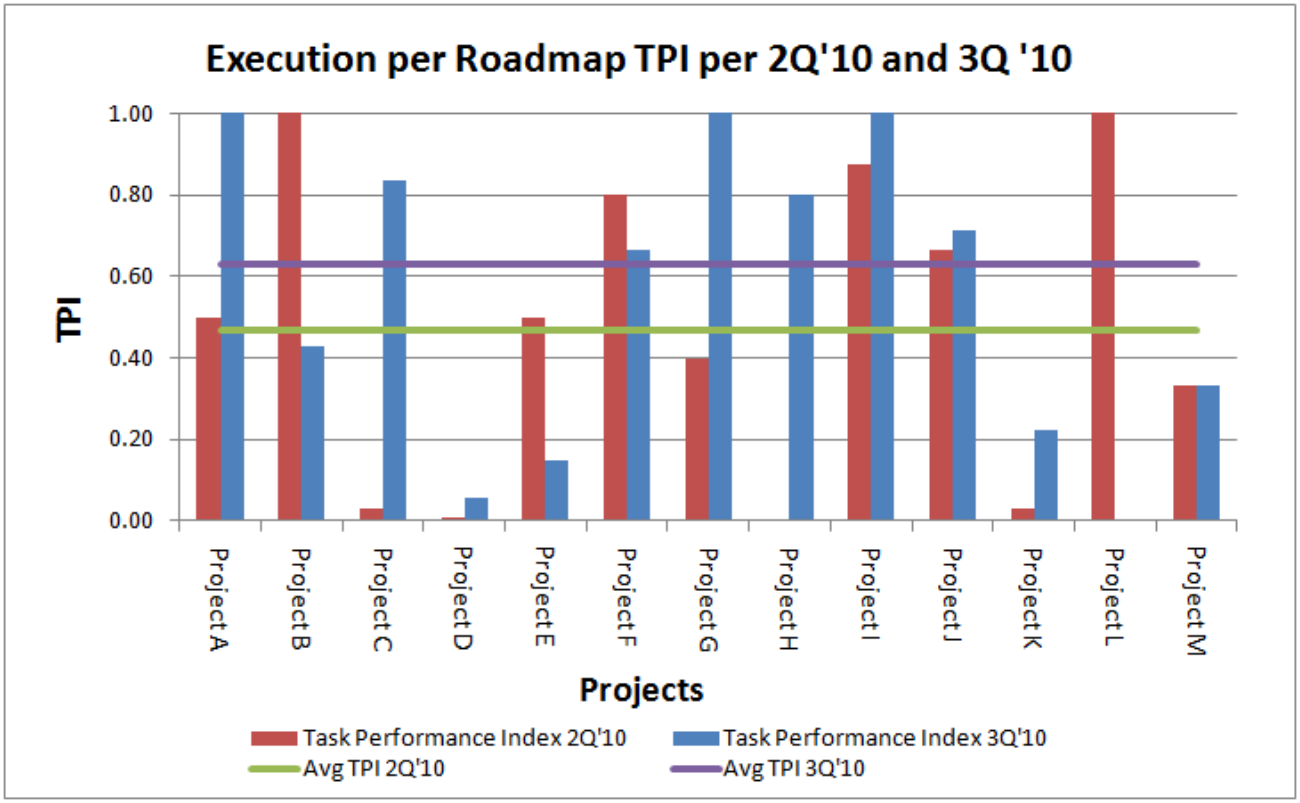
- Identify planned and completed tasks in the roadmap

Calculation Method

- Assess the latest 2 quarters roadmap to ensure tasks are completed according to their scheduled dates
- TPI = (Tasks Performed) (from quarter n)

  (Tasks Scheduled) (from quarter (n-1))

Execution Per Roadmap Task Performance Index



- Data analysis was done on 13 projects
- Avg TPI 2Q’10 - 0.47
- Avg TPI 3Q’10 – 0.63
- Avg TPI increased from 2Q’10 to 3Q’10

Findings & Actions

- Findings:
  - Planned vs. Accomplished tasks shows that tasks are accomplished but not 100%
  - Projects were not using the current version of roadmap tool
  - Some projects have gone back to the older version of the roadmap making it difficult for analysis

- Actions:
  - SE Lead will have to be very specific on updating Roadmaps
    - Very specific on dates to understand if a task is completed or not
    - Current status should indicate if a task has a new completion date
  - All the projects should use the latest version of Roadmap tool
  - Provided metrics data to project management - System engineering area lead
    - Early indication to track a technical review

Conclusions

- Provide early indication of potential issues
  - Corrective actions can be taken immediately when required
  - Markers for improvement in performance
- Sister Organization (PM) responsible for collecting data on overall project cost, schedule and performance metrics
  - Leverage their metrics data to assess SE Return on investment
  - Goal is to quantify the value of SE – Project performance vs. Project cost
- Value of SE OSPs can be assessed
  - SE documents can be improved to add more value to projects
- Lessons learned documented in the quarterly data analysis
  - Management supports continuing metrics collection
  - SE Metrics will evolve with time, to stay relevant to current project environment

Questions?