Civil Group - SIS

Space Mission Operations DBMS (SMOD)

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SpaceOps2006

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Agenda:

- Abstract…

  Executive summary
- Background…

  Problem statement and analysis
- Space Mission Operations DBMS…

  A proposed solution

Abstract

Communications among mission support software hasn't changed much even as new technology has become available.

DBMS is mature technology that ties together these tools and offers benefits justifying the proposed process changes.

Background

- Mission planning workflow…

  Proposing, evaluating, scheduling, and uploading action commands; collecting, processing and correlating resulting data products

- Mission Timing cycles…

  Long term, fixed scientific goals; daily planning, responsive actions

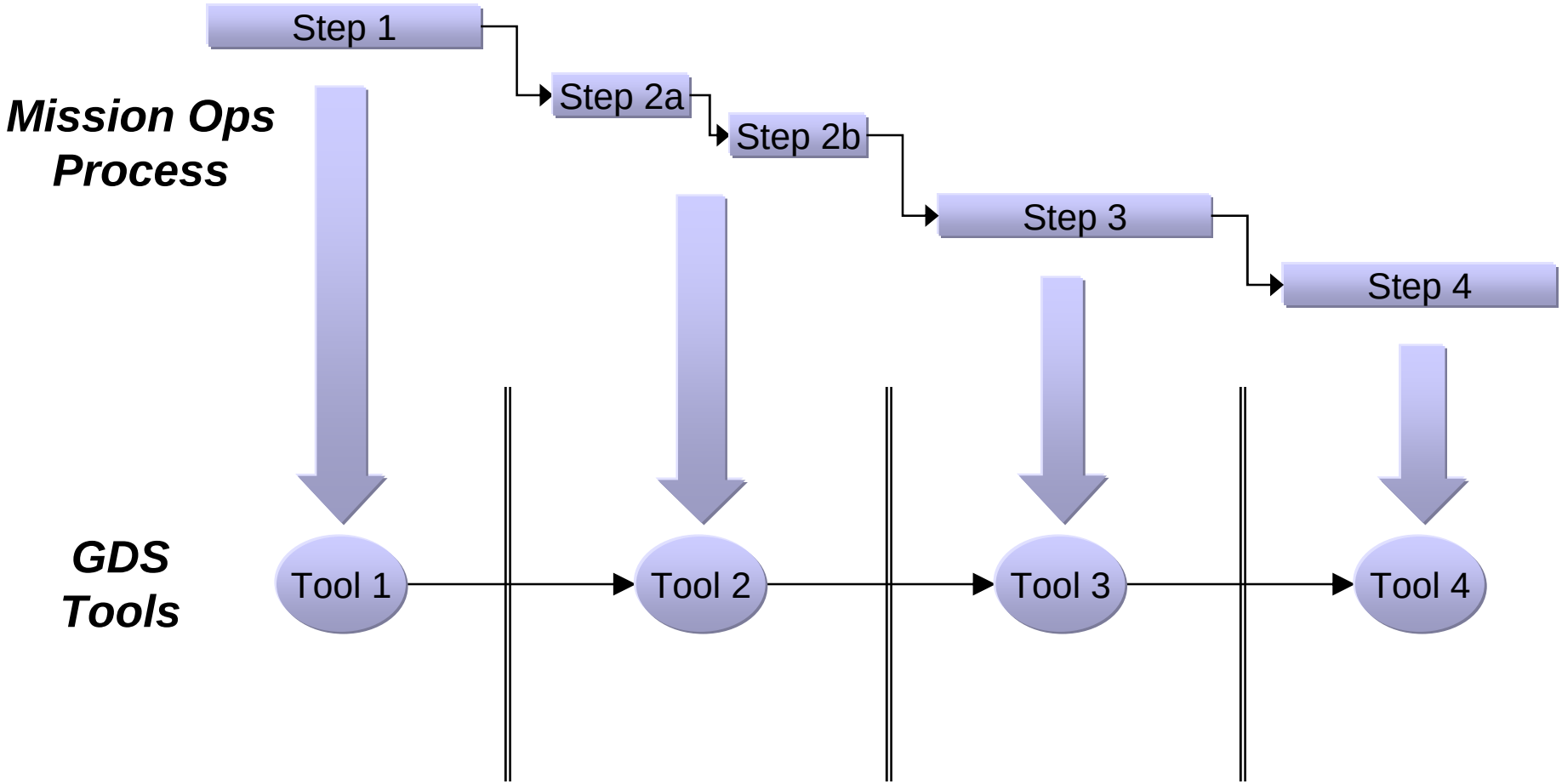
- Evolving technology…

  From flat files to XML to shared database

- Recent examples from MER…

  Maestro/Ensemble and SPIF-e, a NASA collaboration using a DBMS

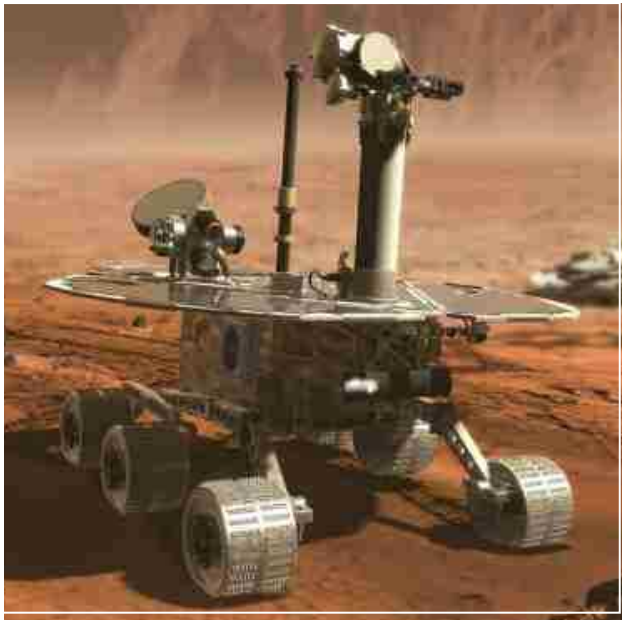
Mission planning workflow…



Ref: Jeff Norris, JPL, 14 Oct 2005

Mission planning workflow

MER mission science planning is a typical multiple tool space operation workflow



Science Activity Planning
- Request activities
- Set priorities

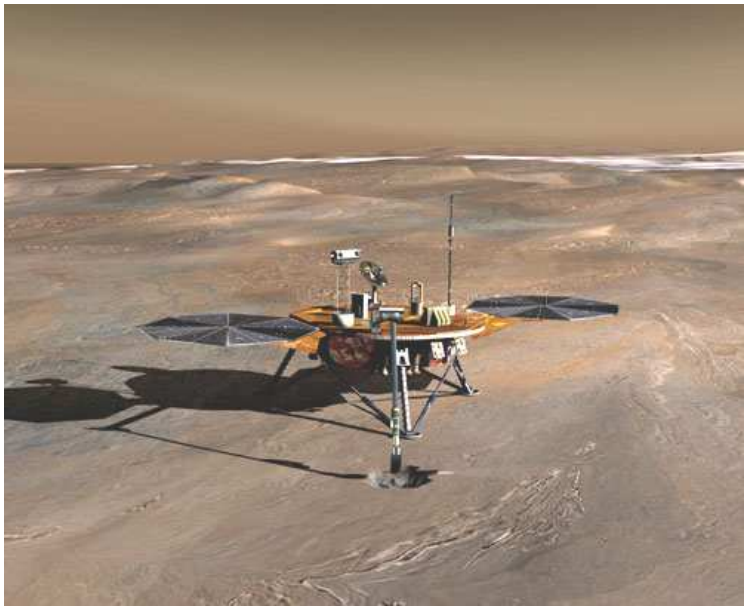
Constraint Editor
- Add constraints between activities

MAPGEN
- Plan selected activities within resources, flight rules

Command Sequencing

Mission Timing cycles…

Phoenix Mars Lander has to survey before scoping samples for analysis



Cassini mission was planned years in advance

Mission Timing Cycles…

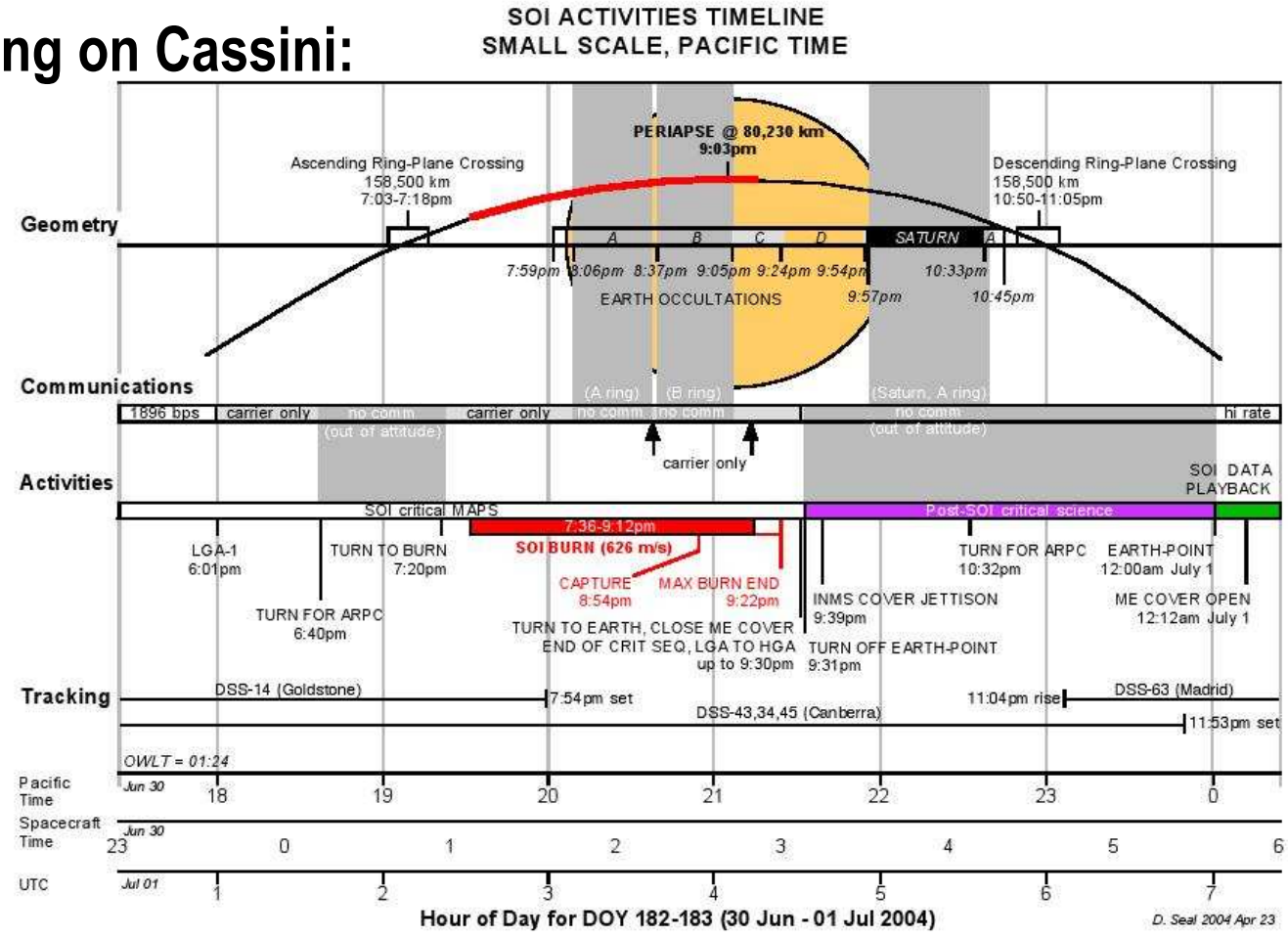
However:

‘During its four-year nominal mission, the Cassini spacecraft will make nearly a quarter of a million observations. Understandably, then, the entire science planning process is a monumental effort. The observation planning for Cassini’s nominal mission ostensibly ended over a year ago, meaning the bulk of the spacecraft’s prime mission observations are cast in stone or at least rapidly-hardening concrete. Numerous factors have, however, dictated changes in the nominal mission trajectory, shifting several observations out of their “window of opportunity.” ’

- Cassini Investigation Scientist/Science Planning Engineer Dr. Kevin R. Grazier of the Jet Propulsion Laboratory, lunch-time talk abstract

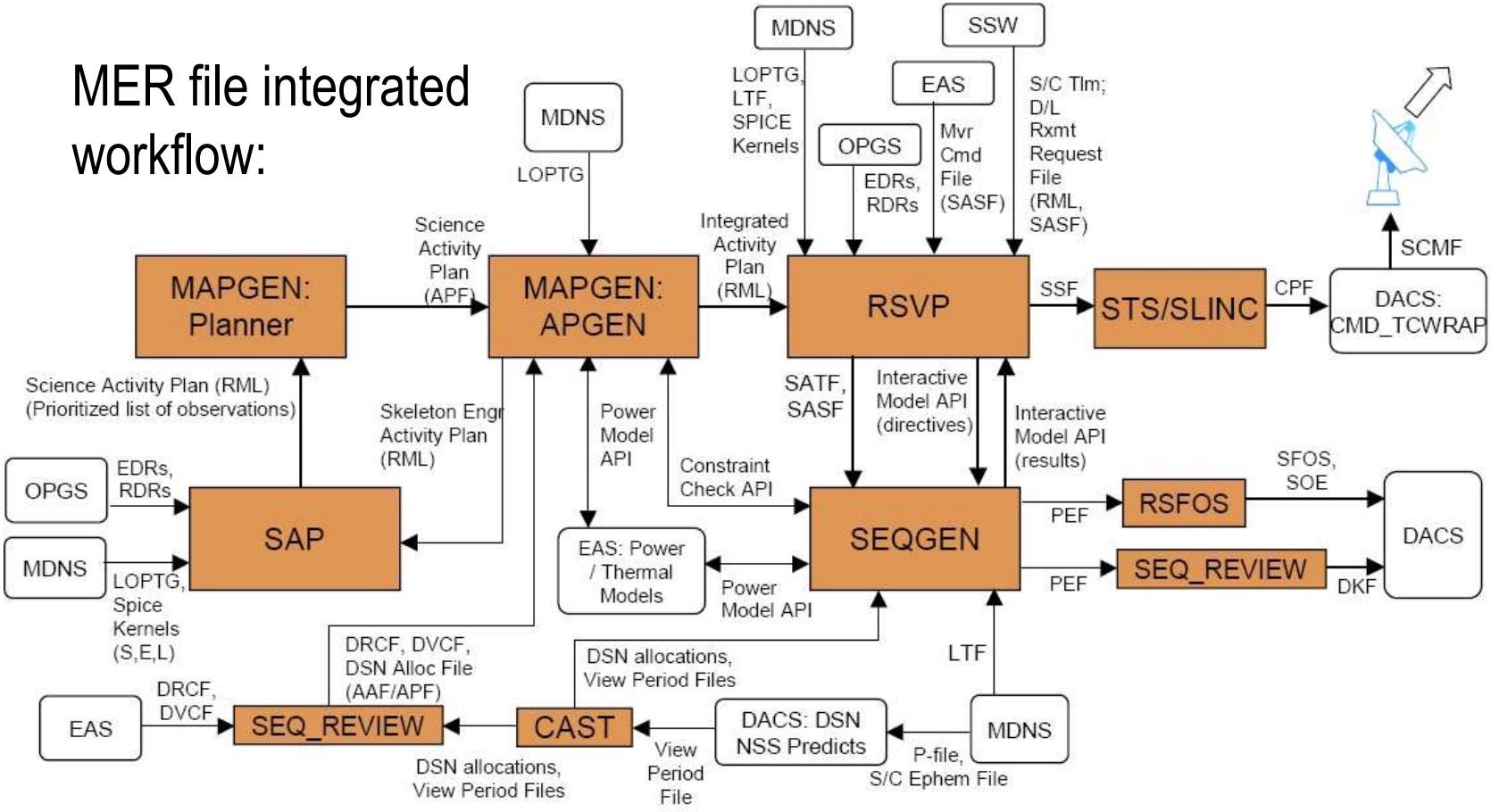
Mission Timing Cycles

Daily planning on Cassini:



Evolving technology…

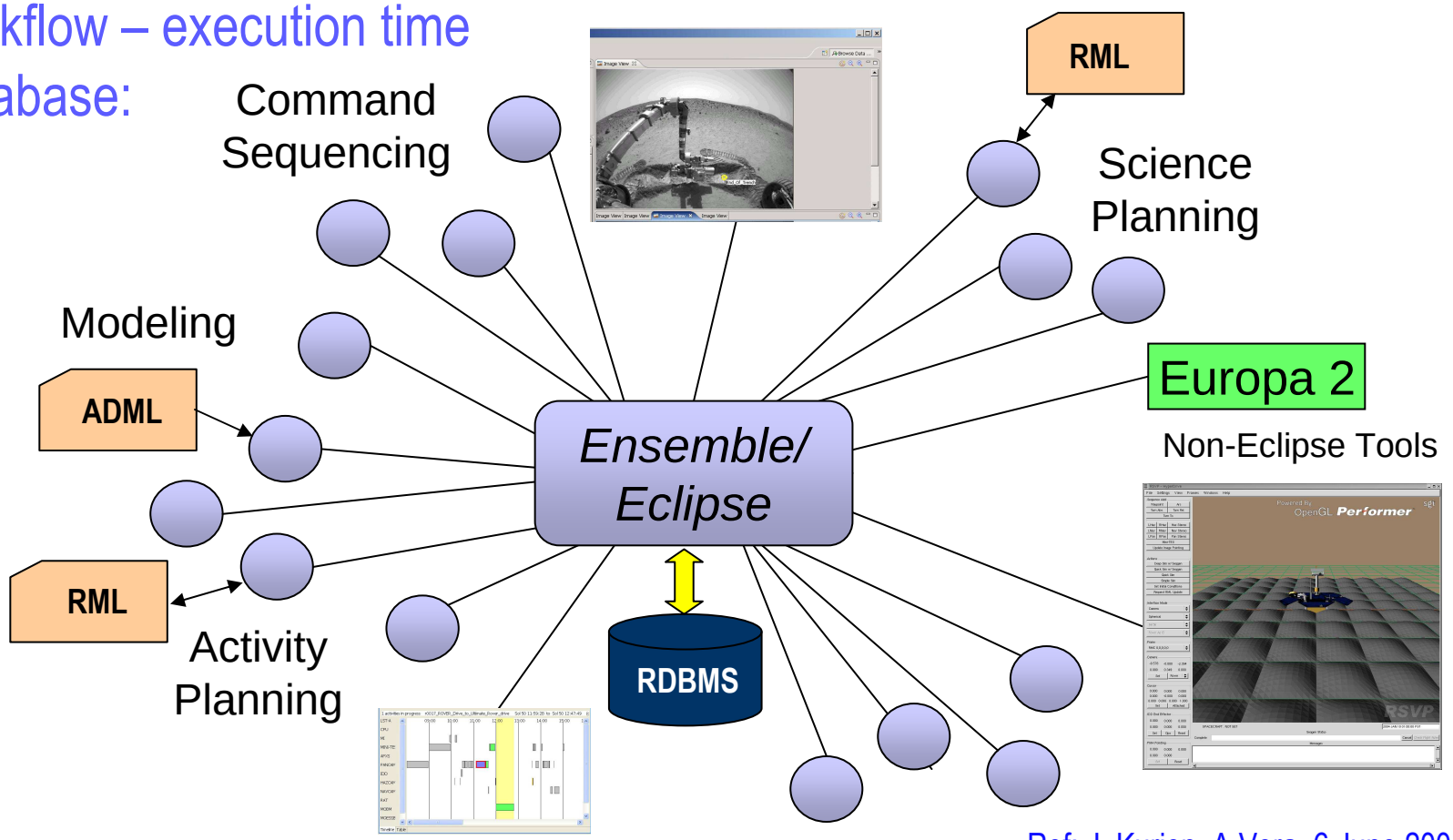
MER file integrated workflow:



J. Kurien took these out of a presentation R. Rasmussen gave to the MSL project in May 2005.

Recent examples from MER

Ensemble integrated workflow – execution time database:



Ref: J. Kurien, A Vera, 6 June 2005

SMOD - A Proposed solution

- Database is primary repository

  All activities are entered and stored in the RDBMS and the mission is considered a continuum of these activities

- Activity-centric workflow…

  Activities move through states such as proposing, evaluating, scheduling, uploading commands and collecting, processing and correlating results

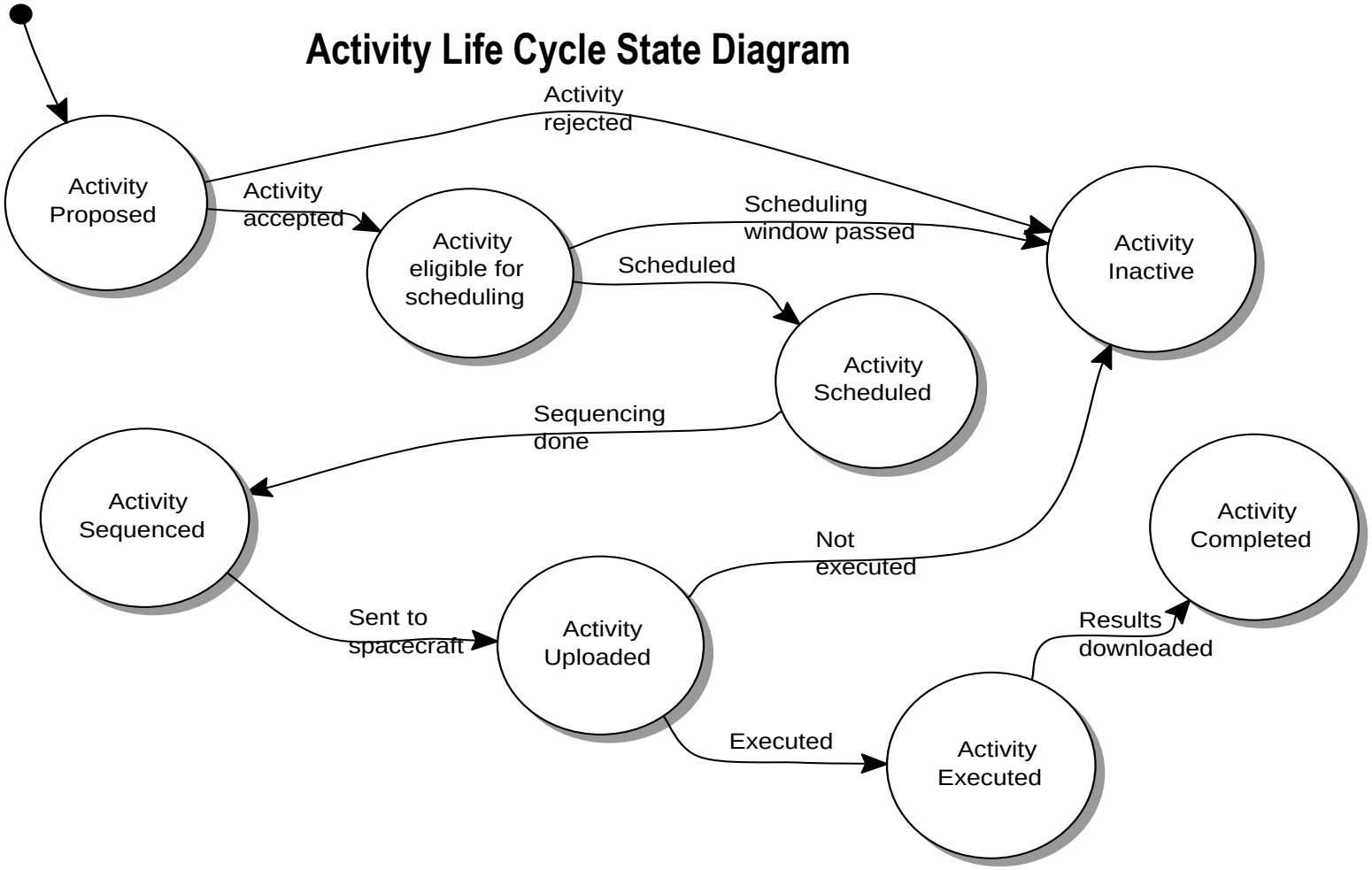
- Query-based multiple views…

  Activities are organized via queries into various groups and views

- Gain RDBMS benefits…

  IT has evolved many useful procedures for storing, protecting, accessing, and managing DBMS-based applications

Activity-centric workflow



Query-based multiple views

- **All activities over a period of time:**
  - **Select * from activity a where a.starttime >= {time1} and a.starttime >= {time2}**
- **All engineering activities over a period of time:**
  - **Select * from activity a where a.starttime >= {time1} and a.starttime >= {time2} and a.owner_dept = “Engineering”**
- **All scheduled activities over a period of time:**
  - **Select * from activity a where a.starttime >= {time1} and a.starttime <= {time2} and a.state = “scheduled”**
- **Activities of a named “plan”:**
  - **Select * from plan p, activity a where p.name = {theName} and a.starttime >= p.time1 and a.starttime <= p.time2 and a.owner_dept = p.owner_dept**

Exploiting Information Technology benefits

- High database integrity

  RDBMS provide user access controls, ensuring internal consistency, backup/restore, replication, and audit trails for reviews are available

- Single definition of each activity

  One instance of an activity will exist in the database from womb to tomb, moving through states until it is rejected or uploaded

- Multiple access

  Activities can be reviewed by any number of users simultaneously and even modified by one – with proper controls, multiple users could even manipulate activities for collaborative planning

- Tool integration…

  Modifying applications to be DBMS-based is much easier with common API libraries

Tool integration via RDBMS…

Application Programming Interface (API) libraries

- Fastest, most complete – full access to features
- Language independent
  - Open Database Connectivity (ODBC) for C, C++, Perl, etc
  - Java Database Connectivity (JDBC)
  - Object Relational Mapping (ORM) e.g., Hibernate
  - Common database information in application language formats
- Platform independence
  - Database server and clients may differ (e.g., Sun and PC/Mac)
  - Web browser access to common information

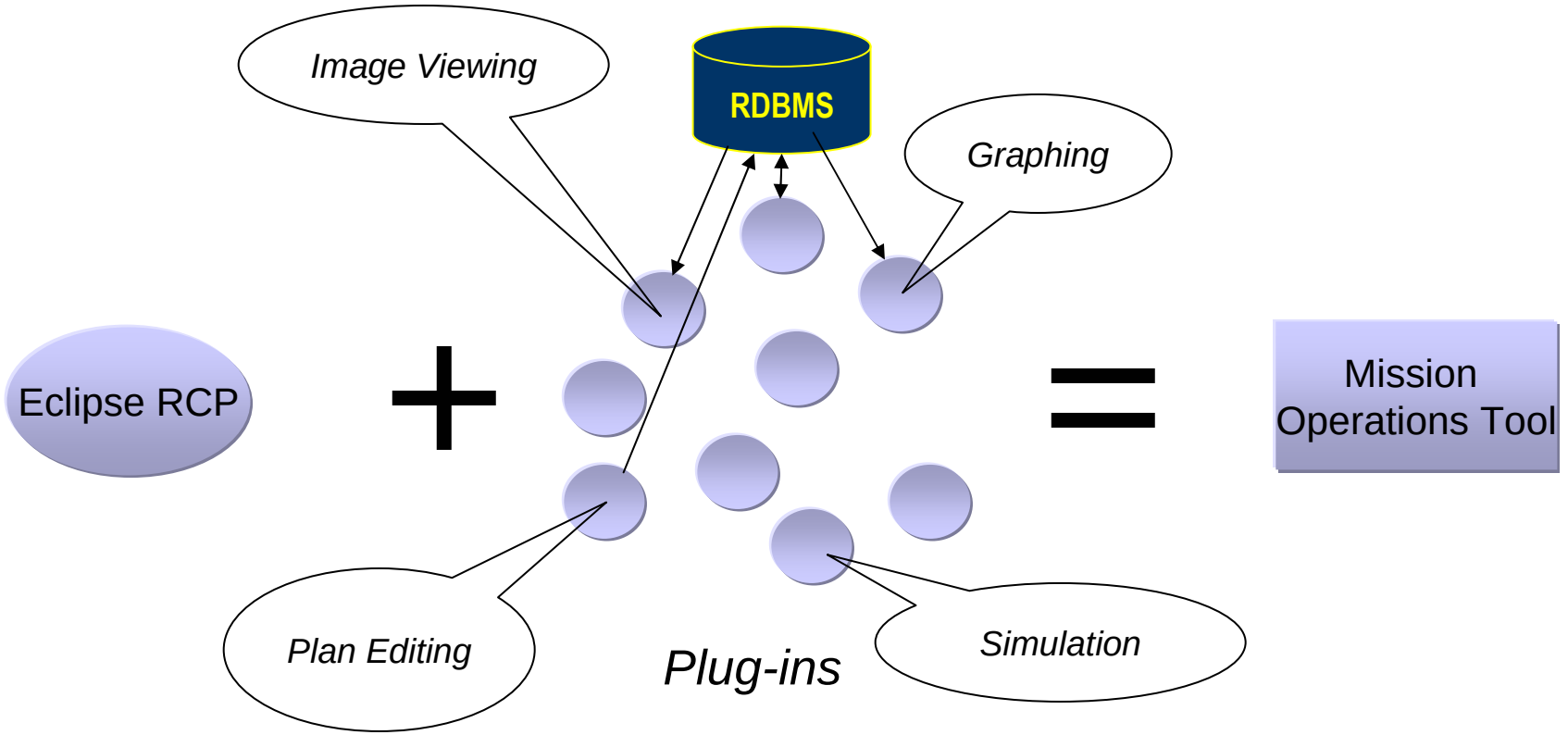
Tool integration via RDBMS

Interfacing via legacy files

- Minimum impact on existing applications
- Provide Import/Export applications
  - Extract information and write legacy format input files
  - Read and store information from legacy output files
- Database can control “checkout/check-in”
- Limited functions
- Database remains the one true data source

Tool integration via RDBMS

Integration component software, e.g., Ensemble Eclipse-based Rich Client Platform:



Conclusion

Modern RDBMS allows for new ways of integrating the many software tools that support space mission operations. By redefining the organization of activities that define the mission and bringing together all of the stakeholders it is possible to gain the benefits of robust data, reduced preparation time, traceability, security and easy access.

IT departments have developed techniques that can be exploited for these applications. Legacy tools can be converted using APIs or new software to access the data and format it as required.

The benefits of this architecture make the conversions and procedural changes more than worthwhile.