Temporal Reasoning for Mixed Initiative Planning

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Prinicipal Investigators

Dr. Jonathan P. Stillman
Bldg. K1, Rm. 5C31A
GE Research & Development Center
P.O. Box 8, Schenectady NY 12301
Telephone: (518)387-5257
e-mail: stillman@crd.ge.com

Dr. Piero P. Bonissone
Bldg. K1, Rm. 5C32A
GE Research & Development Center
P.O. Box 8, Schenectady NY 12301
Telephone: (518)387-5155
e-mail: bonissone@crd.ge.com

Seminar at Rome Laboratory 11/9/95: Agenda

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Background, recent progress overview	**Jonathan Stillman**
Inconsistency Diagnosis, Client-Server architectures	**James Farley**
Hierarchical constraint systems	**Richard Arthur**
Future directions, conclusions	**Jonathan Stillman**
System demonstration	**all**

Goals & Approach

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Goals:

- Tools and techniques for managing temporal aspects of the military planning process, including:
  - Course of action development and adaptation
  - temporal analysis in mixed-initiative and automated planning systems,
  - capture, refinement, and communication of early phase plans through various levels of command, e.g., CINC to JFACC.

Approach:

- Continue to build on our work in temporal reasoning as embodied in Tachyon, by developing a true server, enabling its distributed use in batch, interactive (via GUI), and embedded modes. Support use by planning researchers.
- Incorporate Tachyon server into ACPT.
- Develop improved techniques for solving nonconvex systems.

Results & Benefits

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Expected Results:

- Capture and processing of temporal information through all stages of ACPT plan generation. Flexibility of Tachyon re-use. Improved solution techniques.

Intended User:

- Air campaign planners, joint force planners, ARPI researchers.

Technology Gaps Addressed:

- Current tools provide no support for early capture and processing of temporal information. Little is done until detailed scheduling time.
- When a problem (deviation from plan) occurs, fallback is “seat of the pants,” and rationale can be lost.

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TECHNICAL FOCUS:

Trade-offs:

- Representational richness vs. practicality of reasoning.
- Level of prototype maturity vs. technical focus.
- Robustness of approximation algorithms vs. approximability of optimal for anticipated applications.

Tech. Gaps / Problems Addressed:

- Intractability of reasoning in many application needs, addressed via focus on comparative examination of promising approximation algorithms.
- Flexibility of application of temporal reasoning techniques.
- Representational breadth with respect to “soft constraints.”
- Early capture and manipulation of temporal information provides greater adaptability, earlier problem detection, better communication.

Tachyon Background

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Tachyon is a prototype temporal reasoning tool designed and implemented at GE CRD, with support from the ARPA/Rome Laboratory Planning Initiative, where it has been applied to:

- Crisis Action Planning
- Noncombatant Evacuation Operations
- Force Package development and deployment

It uses a graph-based constraint propagation model to:

- specify temporal attributes of events
- specify inter-event constraints, e.g., before, after, overlaps
- reason about the ramifications of changes to events and constraints.
- explore “what-if” scenarios

Several integrated applications have been tested in prototype for ARPI

- Deployment Planning Support
  - Integration with SRI’s SOCAP provides temporal refinement of evolving plans
- Force Development
  - Integration with GE’s CAFE provides maintenance of interforce temporal constraints as forces are expanded
  - Integration with MITRE’s ForMAT provides a mechanism for capturing force constraints as they are developed, and for tracking them as forces are used.

Tachyon Background

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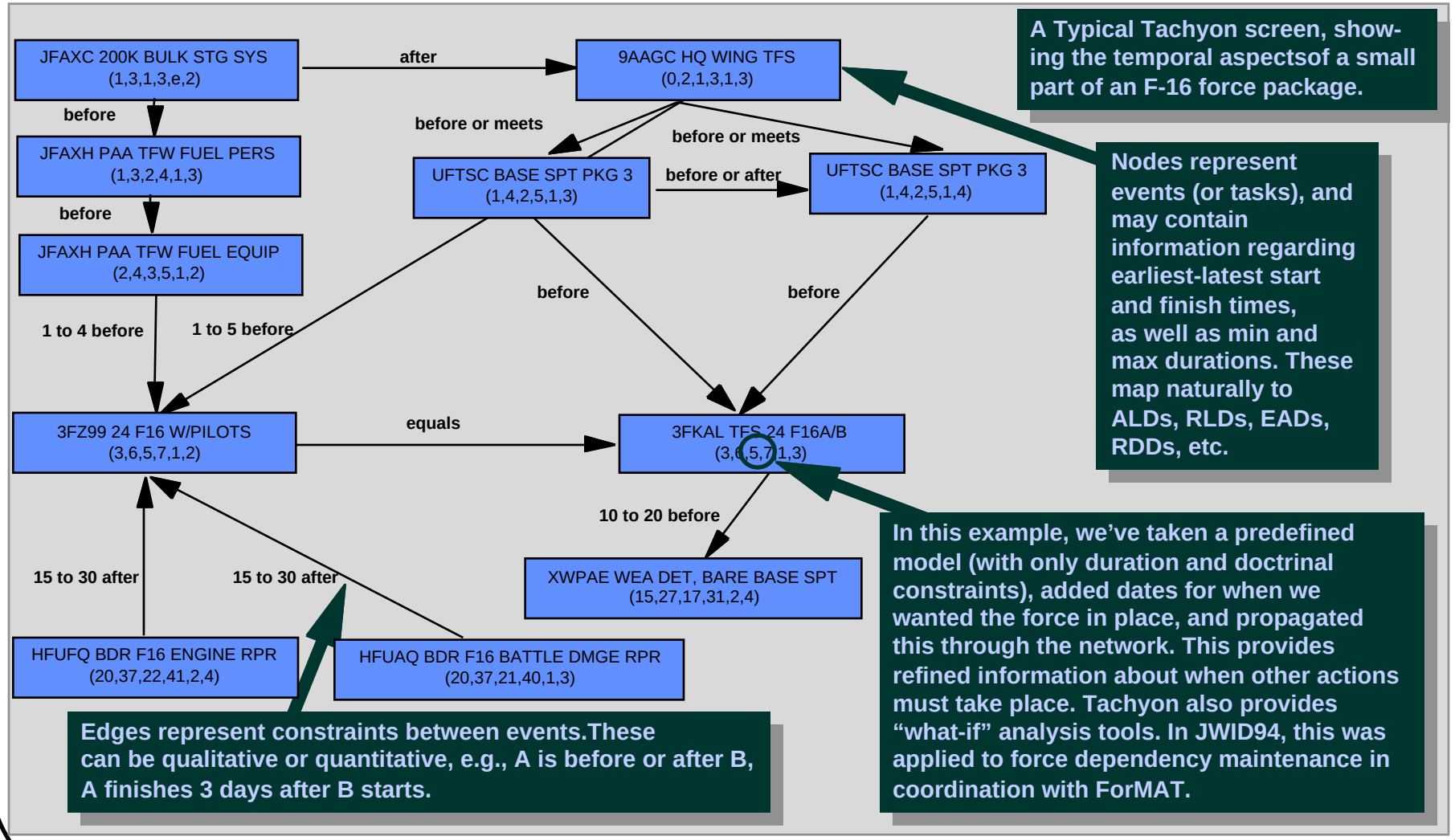
ARPI



Recent Emphasis

- Hierarchies of constraints
- Development and testing of integrated force development capabilities (with MITRE)
- Support for interactive ‘debugging’
- Independent sub-network editing
- Initial design of a more natural resource model
  - multiple resource types
    - reusable
    - consumable, etc.
- Initial design of agent-based client-server architecture
- Initial design of evolutionary algorithm library for temporal constraints.

Technology Transition

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TIEs:

- Tachyon integration into ACPT
- update and extension of Tachyon-SIPE TIE

Possible TIE-related activites:

- Tachyon-O-Plan2
- Integration into CMU scheduler's toolbox
- Support for U Washington SoftBots

Other:

- Tachyon-ForMAT JWID94 preliminary "TIE" is promising for AJP
  - CRD/MITRE visit to Checkmate promising, next visit 12/13
  - CRD/MITRE visit to SOCOM very promising
- Other promising possibilities for JTF
- Re-architecture facilitates use by other ARPI efforts

Technology Development

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Soft constraints

- EC work will facilitate this, even though it was designed with nonconvex constraint propagation in mind.
- Add “lateness mode”

Realizing CS capabilities

- Java client implementation?
- Who do we use as testbed? Likely 2nd phase of CRD/SRI TIE update

Resource model

- First cut at architecture developed, need to examine how/ whether to integrate with other ARPI scheduling capabilities.

Imagery Exploitation

- Expand on model-based exploitation using temporal reasoning in tandem with RADIUS event recognition work.

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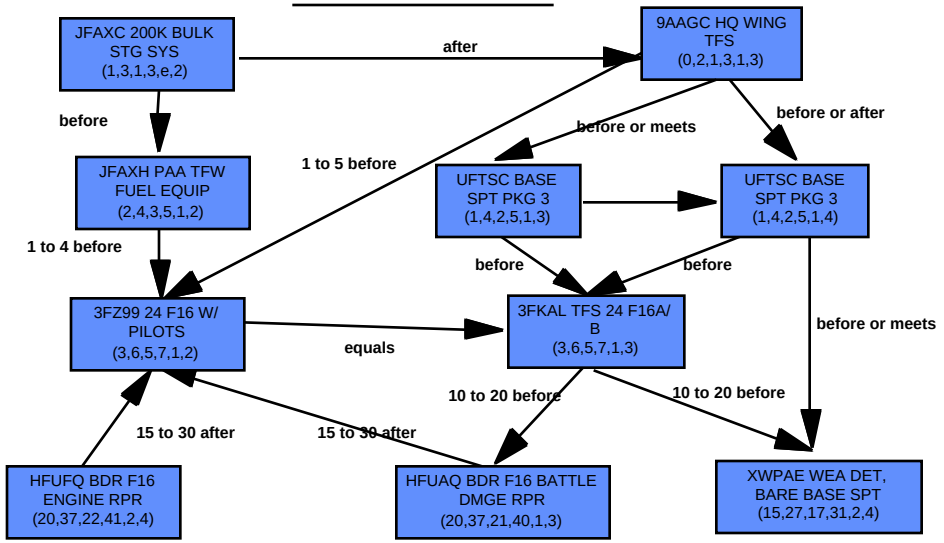
CONCEPT



NEW IDEAS

- Enhance Tachyon's portability, robustness, and ease of use in new applications
- Develop techniques for minimizing cost of processing complex temporal constraint systems (NP-hard)
- Provide smooth flow of temporal constraints from early planning through detailed scheduling to ACPT users in mixed-initiative mode

IMPACT

- Tools and techniques for managing temporal aspects of the air campaign planning process, supporting:
  - Course of action (COA) development and adaptation
  - Temporal analysis in mixed-initiative and automated planning systems
  - Capture, refinement, & communication of early phase plans through various levels of command, e.g., CINC to JFACC

SCHEDULE

Tasks\Contract Months	1 | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 25 | 28 | 31
1. DEVELOP TACHYON SERVER	
1.1 Develop Interactive Query Language	
1.2 Implement Tachyon within client-server model	
1.3 Port GUI-client to CPE (or its successor)	
2. DELIVER ROBUST VERSION OF TACHYON	
3. INCORPORATE TACHYON INTO ACPT	
4. TECHNIQUES FOR NONCONVEX SYSTEMS	
4.1 Tabu Search	
4.2 Genetic Algorithms	
4.3 Exploration of "soft constraints"	
4.4 Comparison and results documentation	
TECHNIQUES FOR ROBUST SCHEDULING	