# A Study on Distributed Cognition for Team Cognitive Process Modeling in ATC

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# Background

- Problem of current situation in ATC

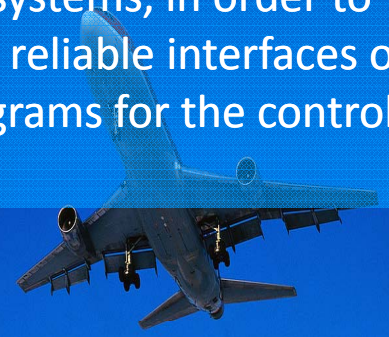
- Increasing  air traffic demands
- Need to increase traffic efficiency, to fulfill various requests
- Prevention of Human errors for keeping air traffic safety


-Supporting for training systems, Real time job, revise rules
- Development design method, Evaluation index

# Purpose of Research

Development method for team cognitive process modeling by using distributed cognition in En-route ATC

Need to understand details of basic functions of air traffic controller's tasks in the systems, in order to design more reliable interfaces or training programs for the controllers



User Oriented, Higher Usability systems for Controllers

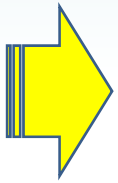
Realization for more efficiency and higher safety of air traffic

# Motivation

- Ethnographic approach

  Ethnomethodology is a method of sociology to find out some implicit orders, rules, or norms behind human activities through observation in the actual work environment

Design of advanced ATC systems for the future



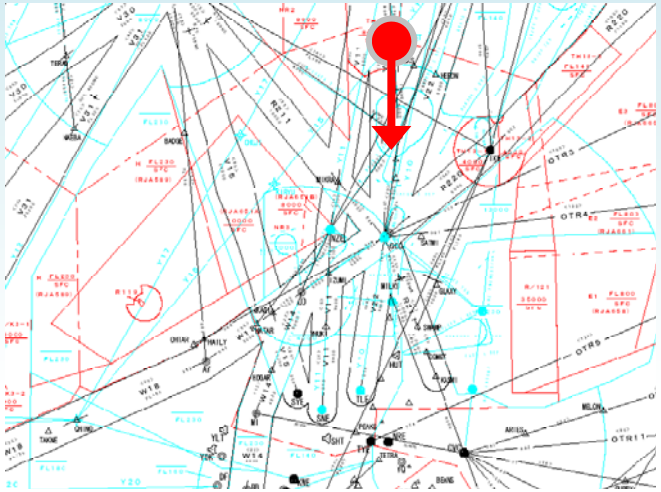
- Assure system safety
- Enhance usability
- Support human reliability

## Understanding of Cooperative Work

(ATC is a cooperative work in between controllers & systems)

- Analysis method of Ethnographical approach ⇒ Distributed Cognition

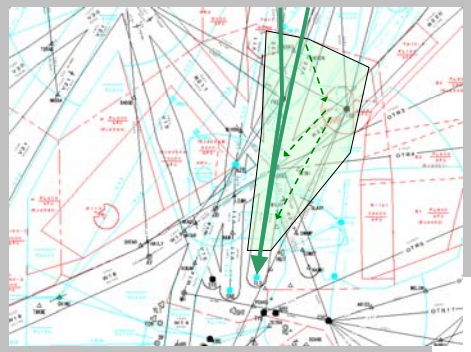
# The Concept of Routine

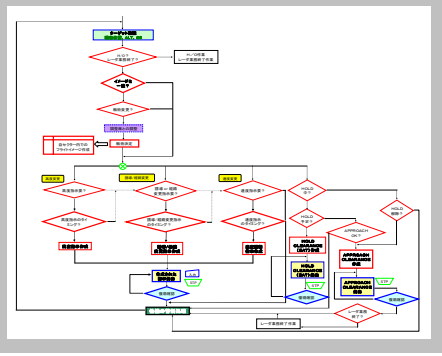


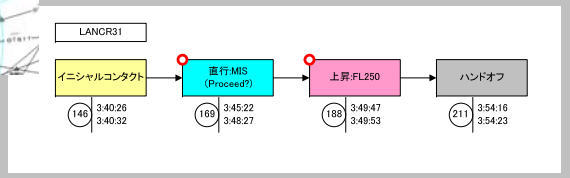
Situation Awareness

<Controller>

<Routine>








<Routines for Targets>

* Relationship between others
* Kinds of Task and Cognitive Process
* Implement Timing
* Contents of Strategy / Tactics

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# Model of Cooperative Work

- Coordination Controller's work is a critical factor for Judgment of Radar Controller's Strategy

Individual Model

Team Model

# Findings from Observation

- *Characteristics of Cooperative work*

  Good cooperative work as a team

  Sharing ⇒ { common strategy, situation awareness

- *Need to understand what is a notion*

  "distribution", "Sharedness", "Overlapping"
  *... as a team cognition*

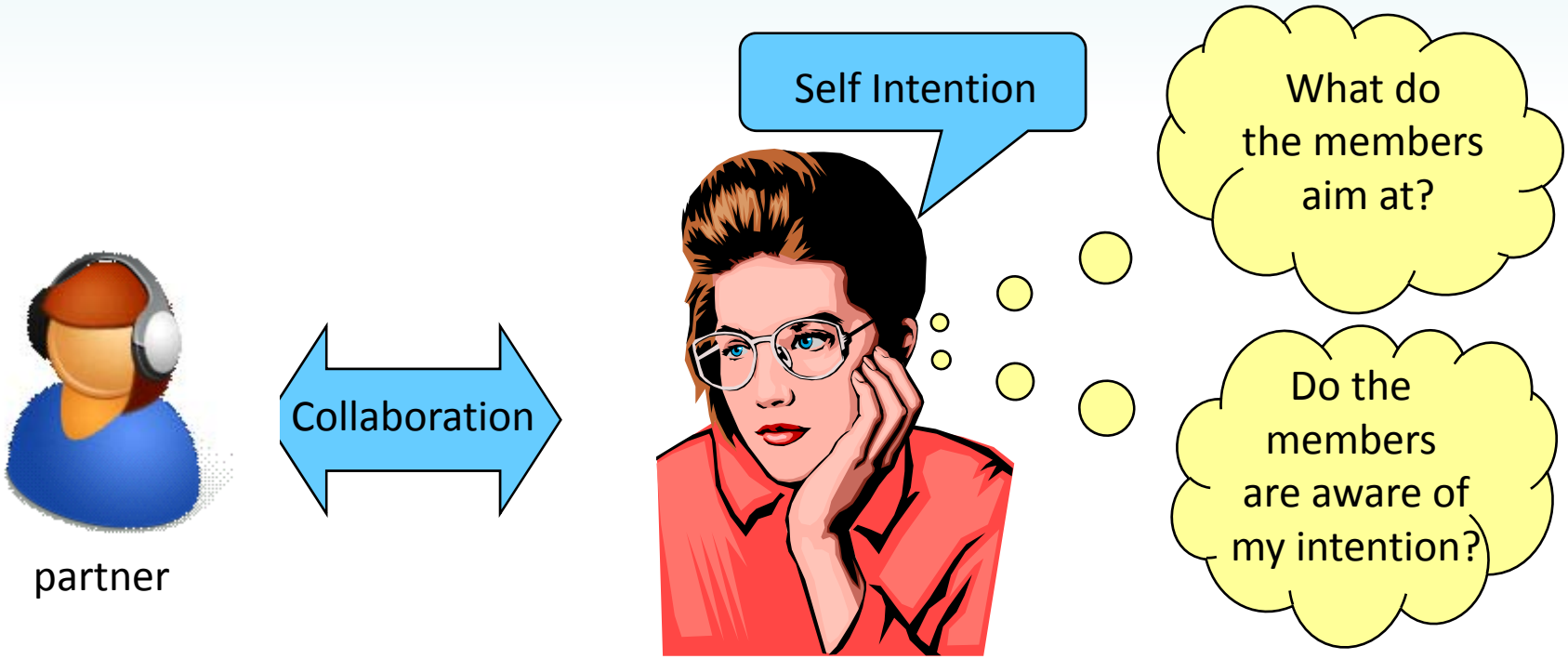
- *Team Situation Awareness (TSA)*
  Defined based on "Mutual Belief"

# Mutual Beliefs

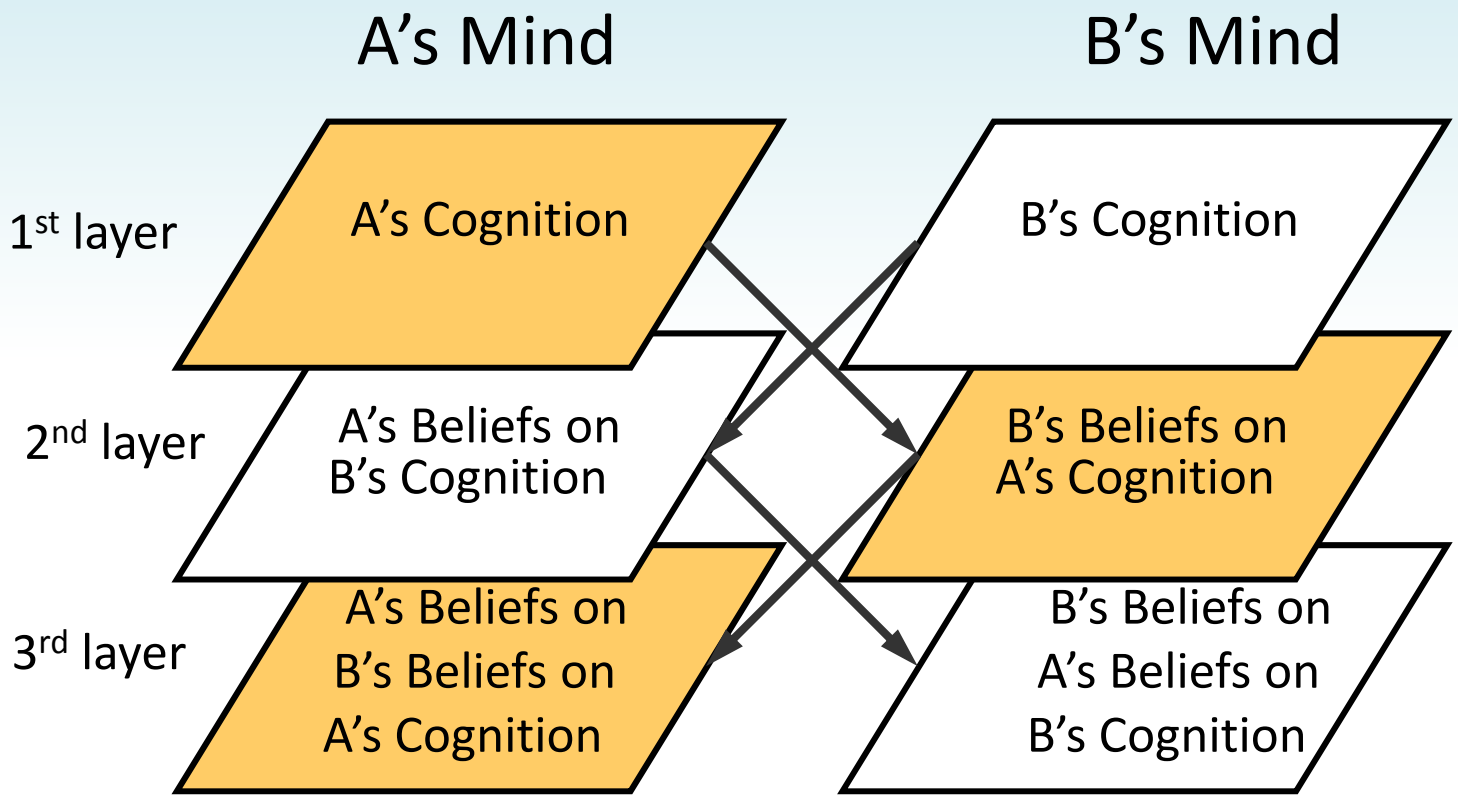
***Team intension =***

***Individual intension***

***+ Mutual beliefs***



# TSA based on Mutual Beliefs



# Team Interaction Related to TSA

- *Four schemes of interaction*
  - Verbal communication
  - Mental simulation (inference)
  - Complementing (assumption)
  - Verification (consistency checking)

- *Four strategies of TSA maintenance*
  - Complement one's own cognitive substance
  - Complement one's own mental simulation
  - Verification to keep consistency
  - Support partner's mental simulation

# Case Study

- *T 03 Sector*

  in Tokyo Area Control Centre,
  Japan Civil Aviation Bureau.

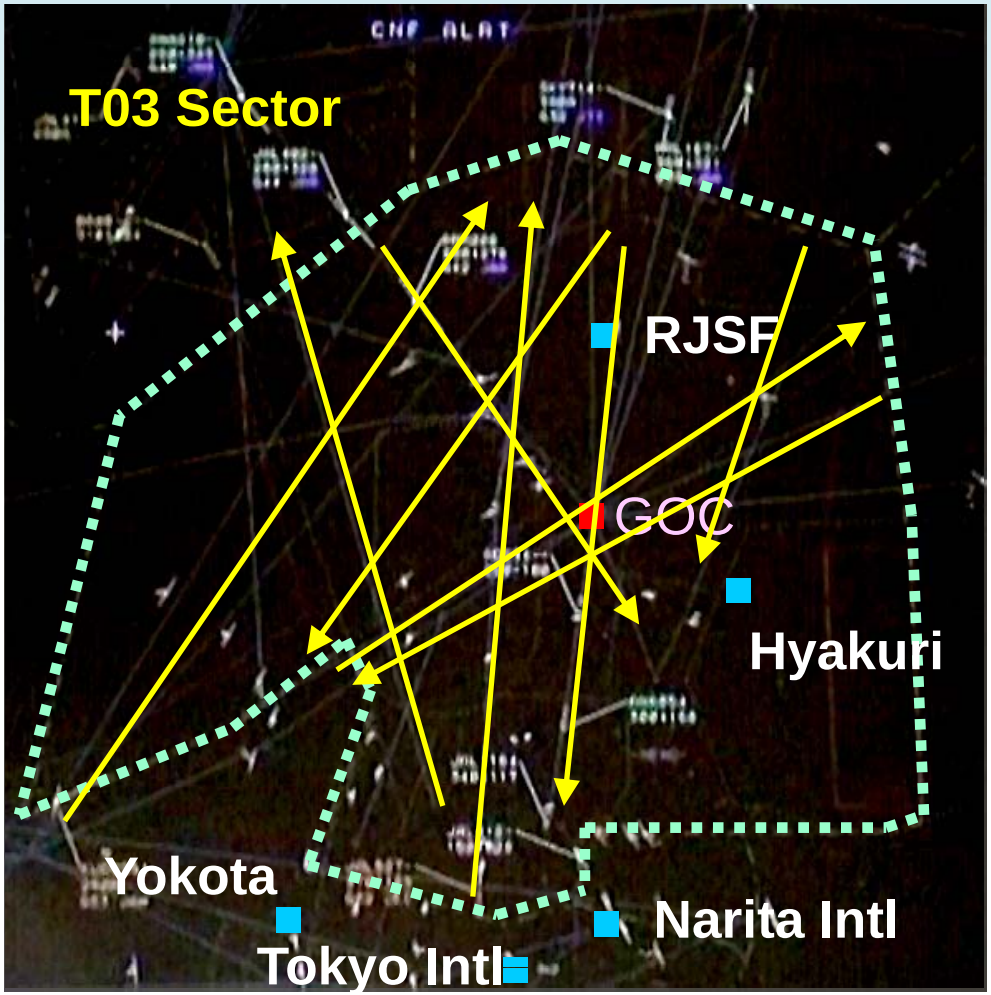
- *Characteristics*

  *Two Main Airport*
  (Narita Intl, Tokyo Intl)
  *Two AFB*
  (Yokota, Hyakuri)
  *Various Type of Traffic*

- *Data Set*

  *Recorded on May 7th 2007*

  Radio Communication ,
  Coordination Communication,
  View of Radar screen&
  Control room



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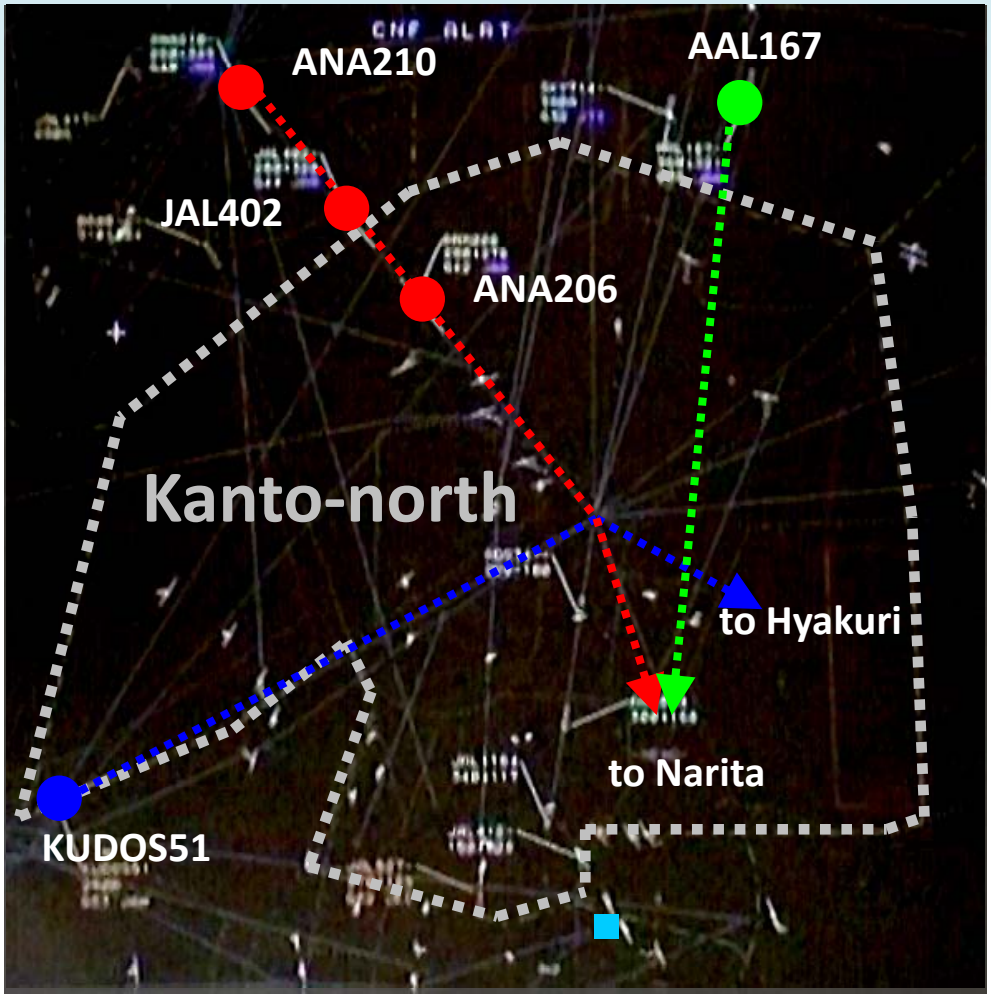



ANA210, JAL402,

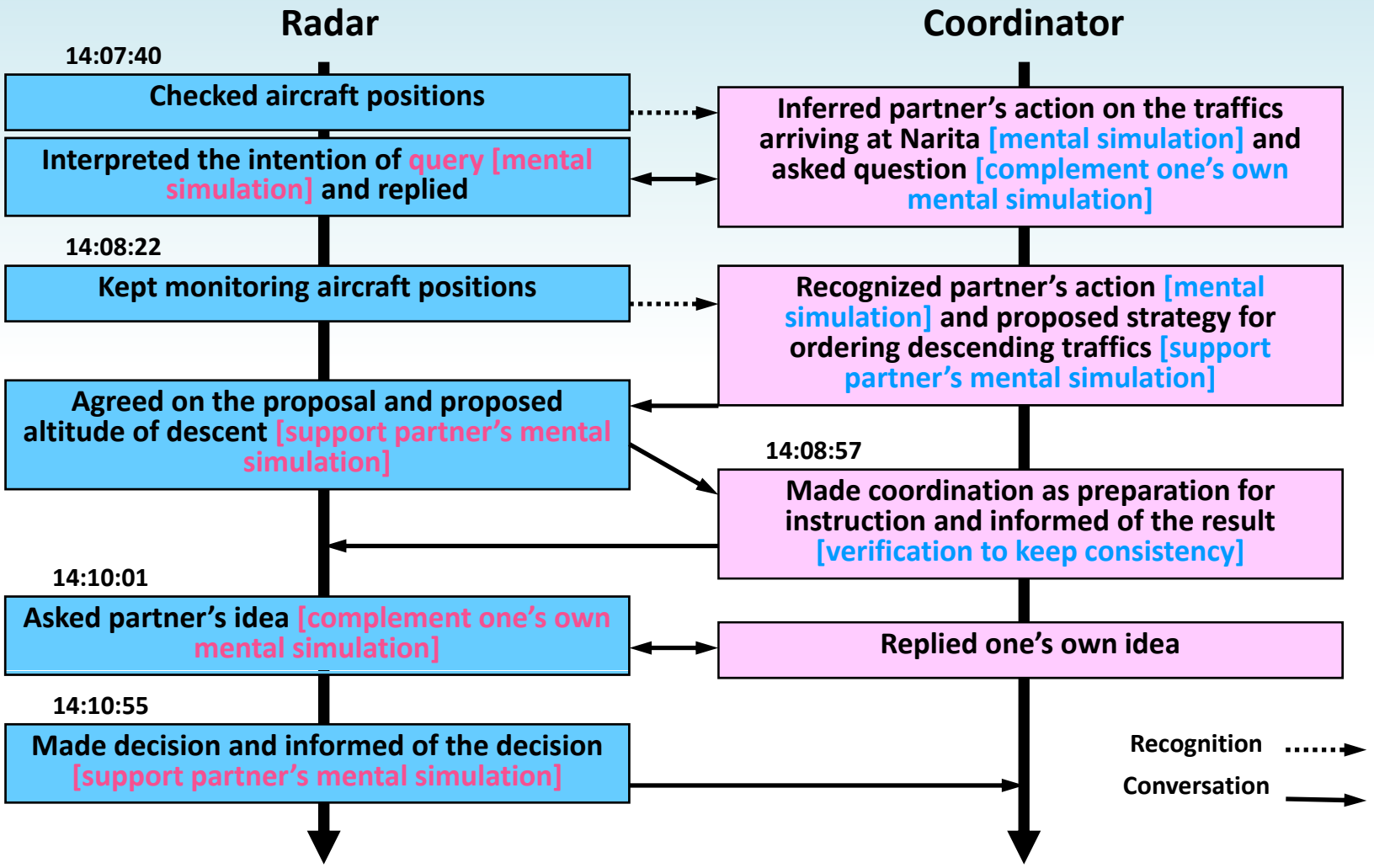
ANA206, AAL167

Descending to Narita airport simultaneously

KUDOS51

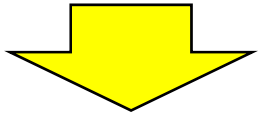
Descending to Hyakuri Air Base

# Collaboration Process (Case study)



# Findings from Case Studies

- **Three schemes of interaction**
  - Verbal communication
  - Mental simulation (inference)
  - Verification (consistency checking)
- **All of the four TSA maintenance strategies**
- **All of the three layers of mutual beliefs**



- **A notion of TSA based on mutual beliefs is applicable to ATC collaboration.**

# Characteristics of Team Collaboration in En-Route ATC

- ***Establishment and maintenance of TSA with and without verbal communication***
  - Shared expert knowledge (routines)
  - Information available in the environment
  - TSA maintenance strategies
- ***Implicit task allocation and execution***
  - Recognition-primed decision-making
  - Shared routines (including role assignment)

# Conclusion

- Introduced a technique for analysing tasks of En-route ATC by the framework of distributed Cognition.
- High performance team work: each partner needs to proactively interact to share their cognitive process
- TSA is based on mutual beliefs in the model. Interactions of TSA are explained as update of individual cognition on the situation and mutual beliefs.

*-Future work-*

- Continue the data analysis to enhance our understanding of detailed features controller's cognitive process model as a team

- Thank you for your attention...

# Acknowledgement

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