SECURE AND FAULT TOLERANT VOTING IN DISTRIBUTED INFORMATION SYSTEMS

14 September 2001

Shambhu Upadhyaya

SPIDER Lab

CSE Department

University at Buffalo

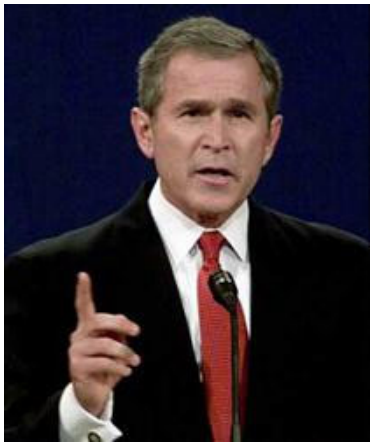
Overview

- Problem Addressed
  - Replication and voting for fault tolerance
  - Secure voting is essential (AFRL/IF & University at Buffalo)
- Techniques Used
  - Distributed monitoring and voter isolation

What About Voting?

Execute an

“Al Gore” - ithm?



Just get an answer and

“stop beating around

the Bush”?

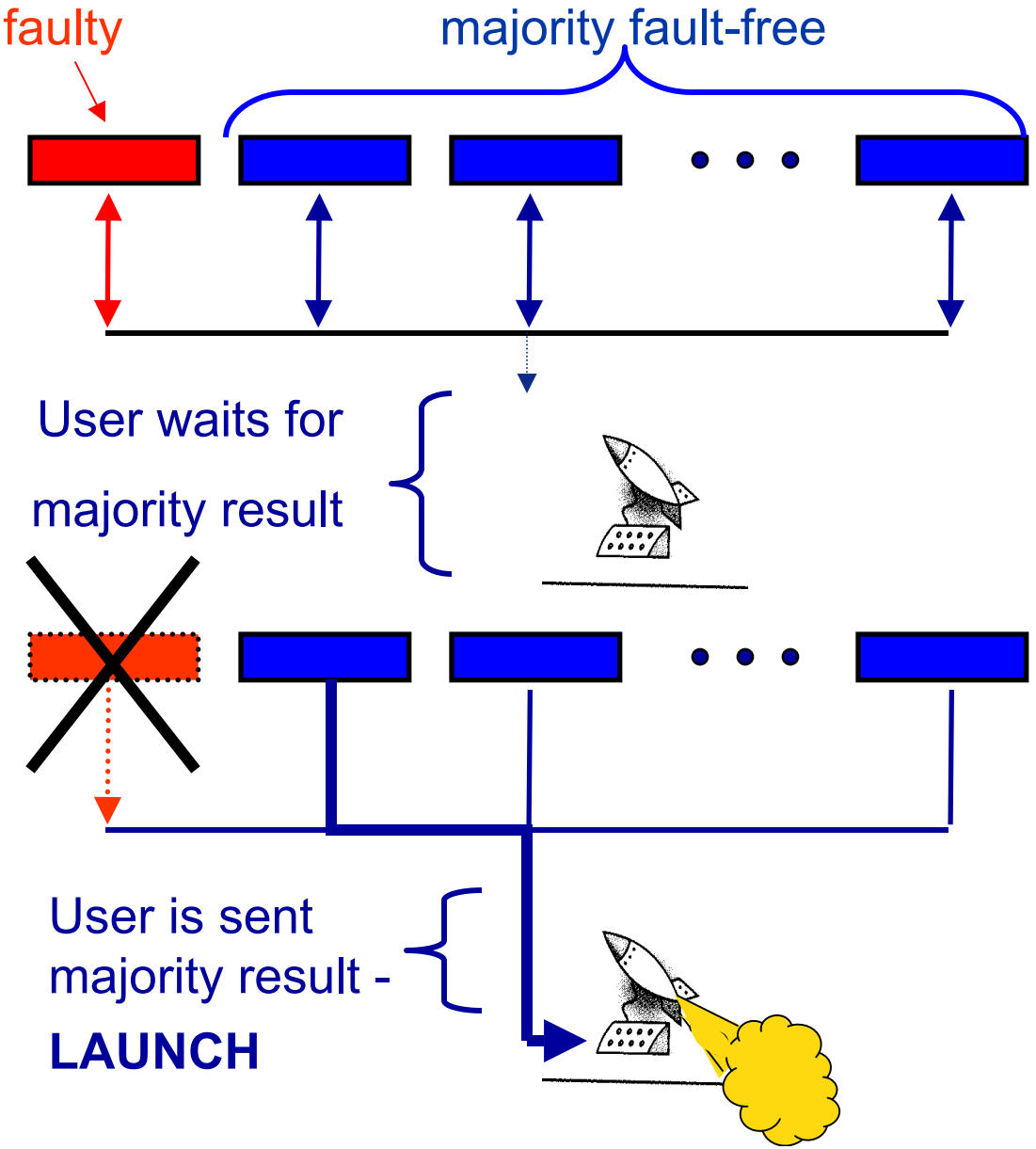
Requirements of Secure Voting

- Eliminating single point of failure in the voting complex
- Correctness and completion of the new voting algorithm -- a formal methodology
- Implementation and application

2-phase Commit Protocols

- Voters exchange their votes and determine a majority result; an arbitrary voter then commits that result to the user
- Fault-Tolerance: what if the committing voter experiences a failure during committal?
- Security: what if the committing voter is compromised?

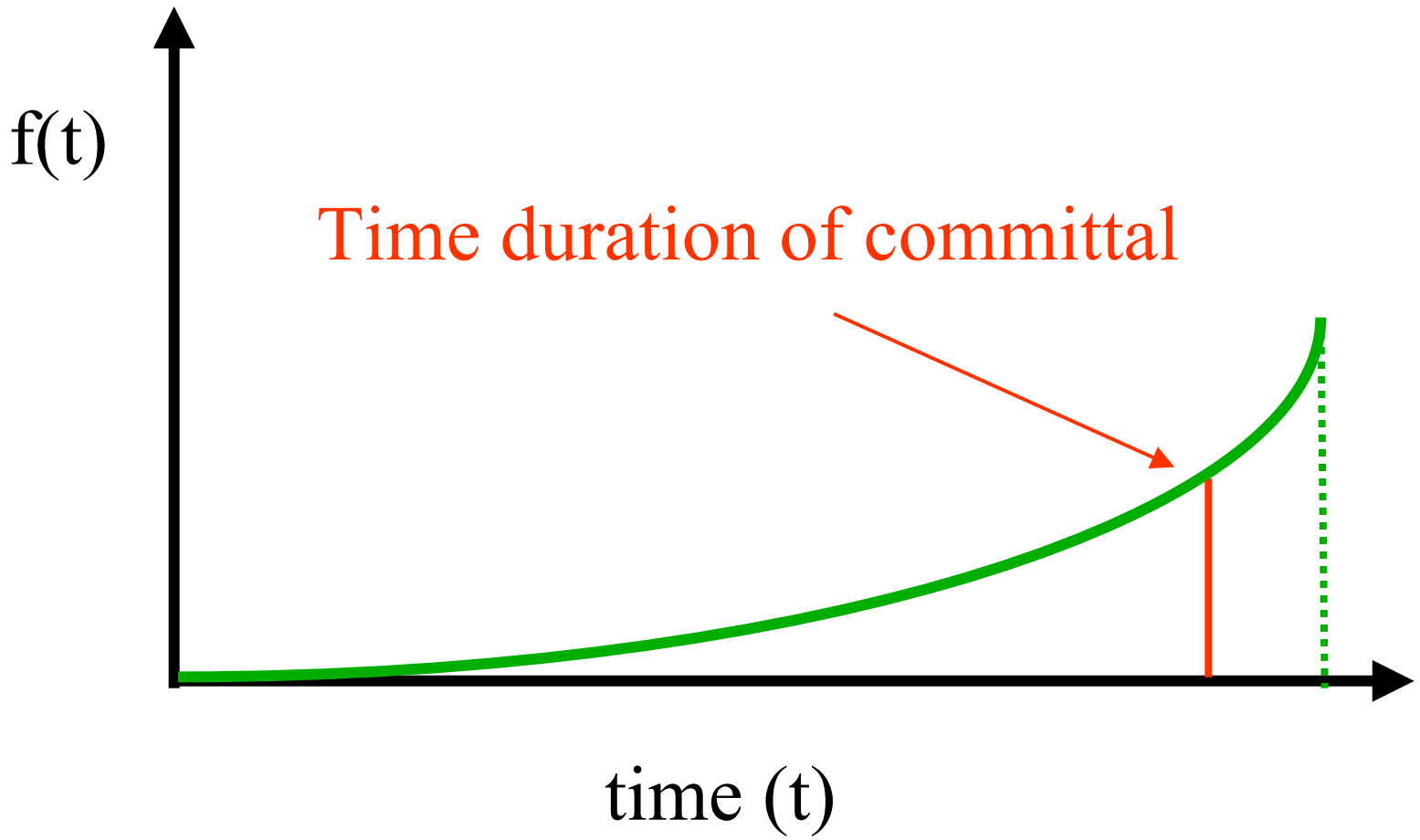
2-Phase Commit Protocol



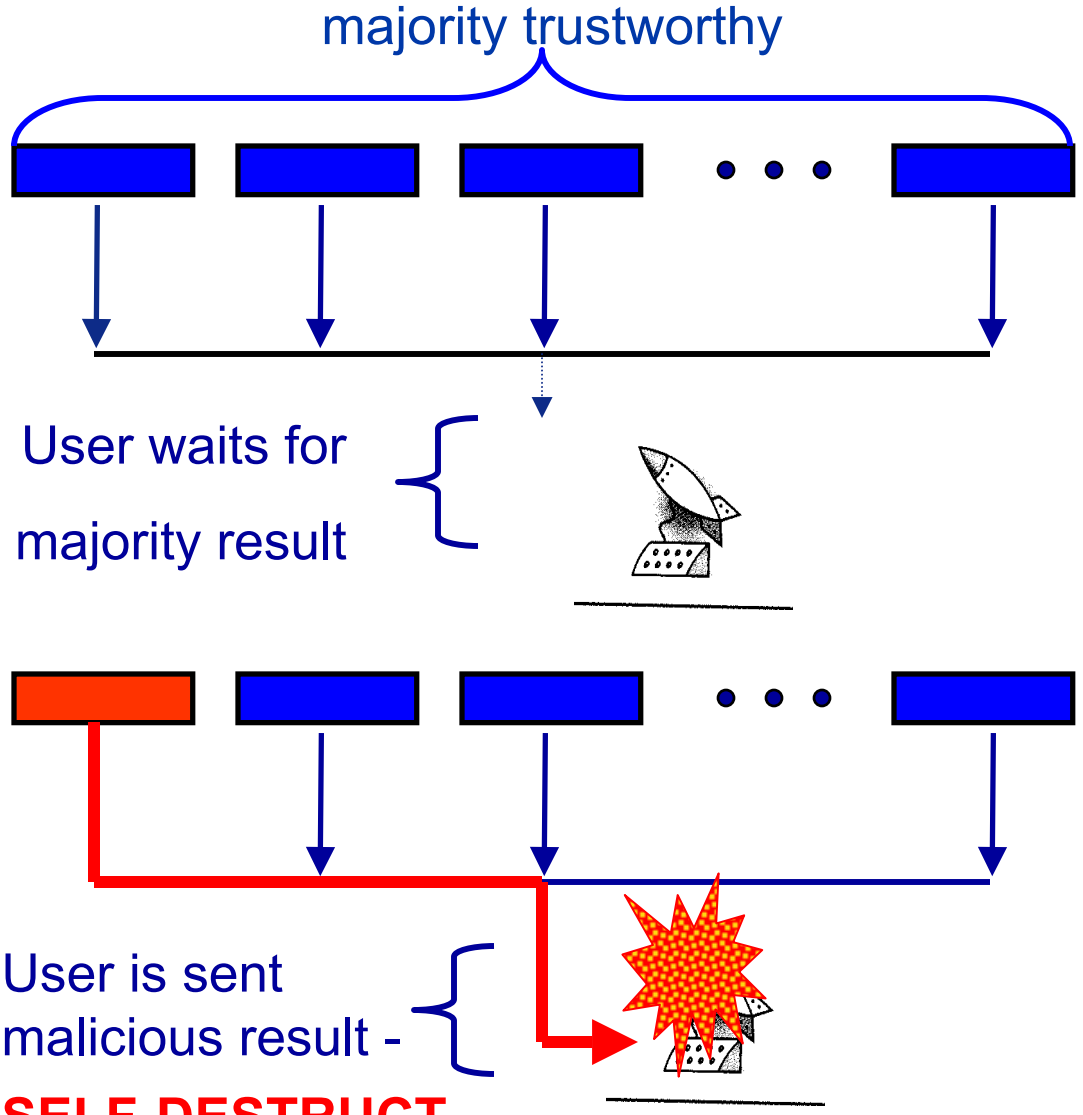
- Phase 1: processors distribute their results and vote on them such that each processor determines the majority

- Phase 2: processor in the majority commits result to the user

Safe Operation



Danger of 2-Phase Commit Protocol

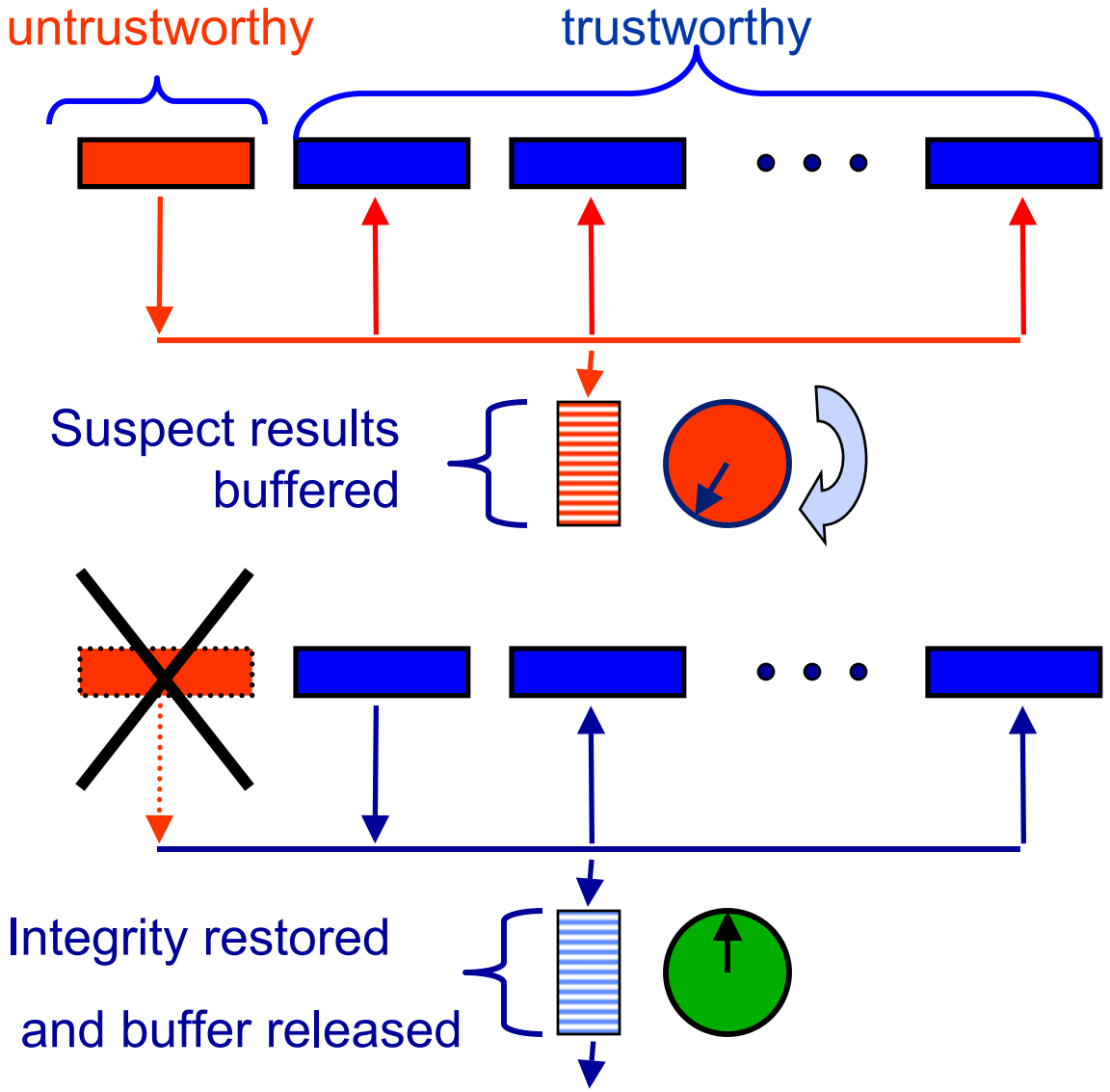


- Phase 1: processors distribute their results and vote on them such that each processor determines the majority

- Phase 2: processor *in* the majority commits result to the user

Timed-Buffer Distributed Voting

(Ref: Hardekopf, Kwiat, Upadhyaya, IEEE Aero 2001)



- Addresses "last mile" of distributed voting
- Buffer until "silence is consent"
- Reverses 2-phase commit protocol
  - Instead of voting then committing - commits first (to buffer) then votes (period of dissension)
  - Prevents disastrous commit phase - unlikely for *classical* fault tolerance but not information attack

Correctness

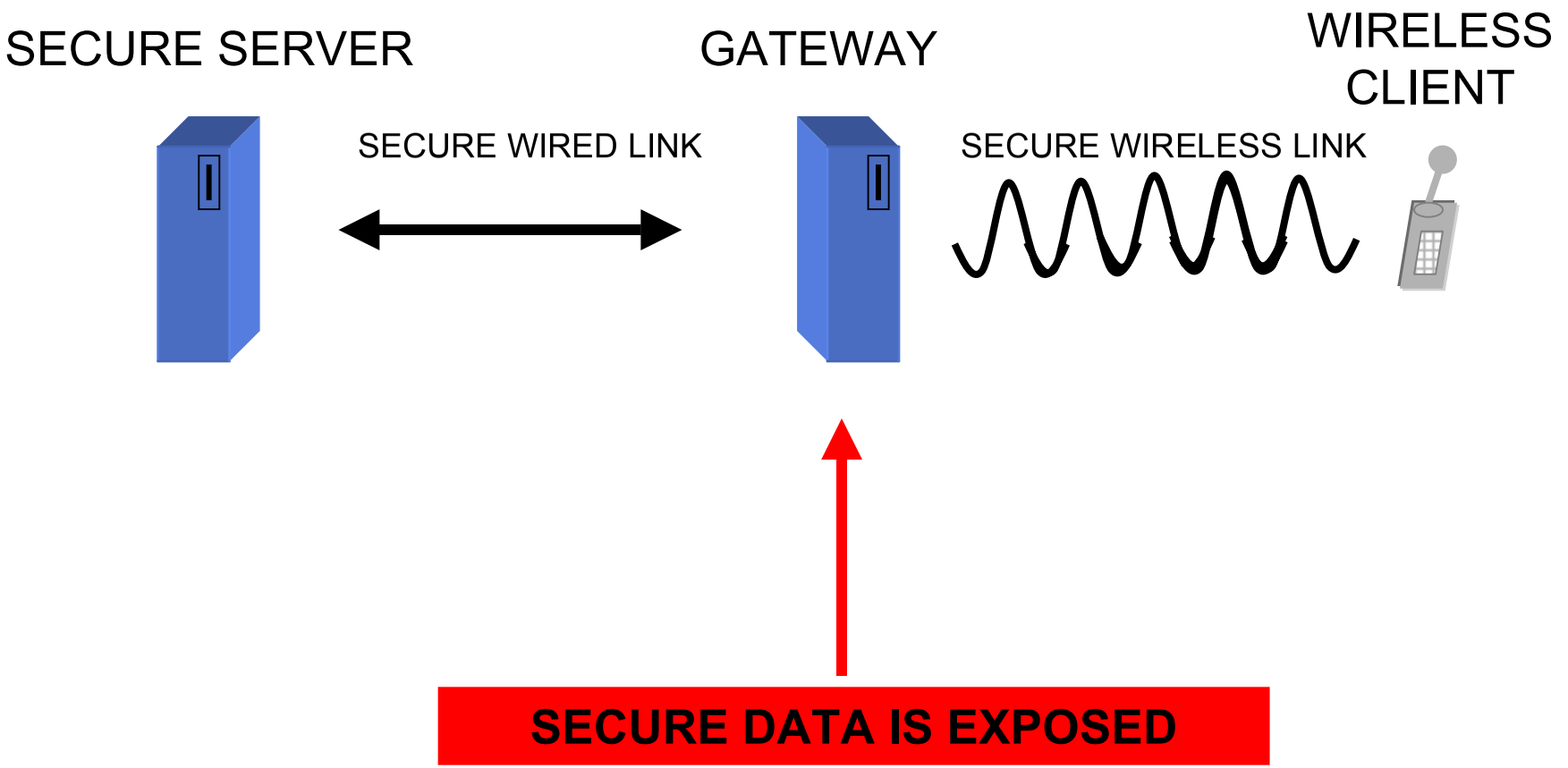
(Ref: Hardekopf, Kwiat, Upadhyaya, SPECTS 2001)

- Used TLA+ to write a formal specification of the algorithm
- Used the specification and TLA to prove both partial correctness and termination

Implementation and Application

- **Being transferred to Assured Communications Research Center**
  - **Instantiation of TB-DVA in Configurable Protocol Stack for the Software Radio Development System (SoRDS)**

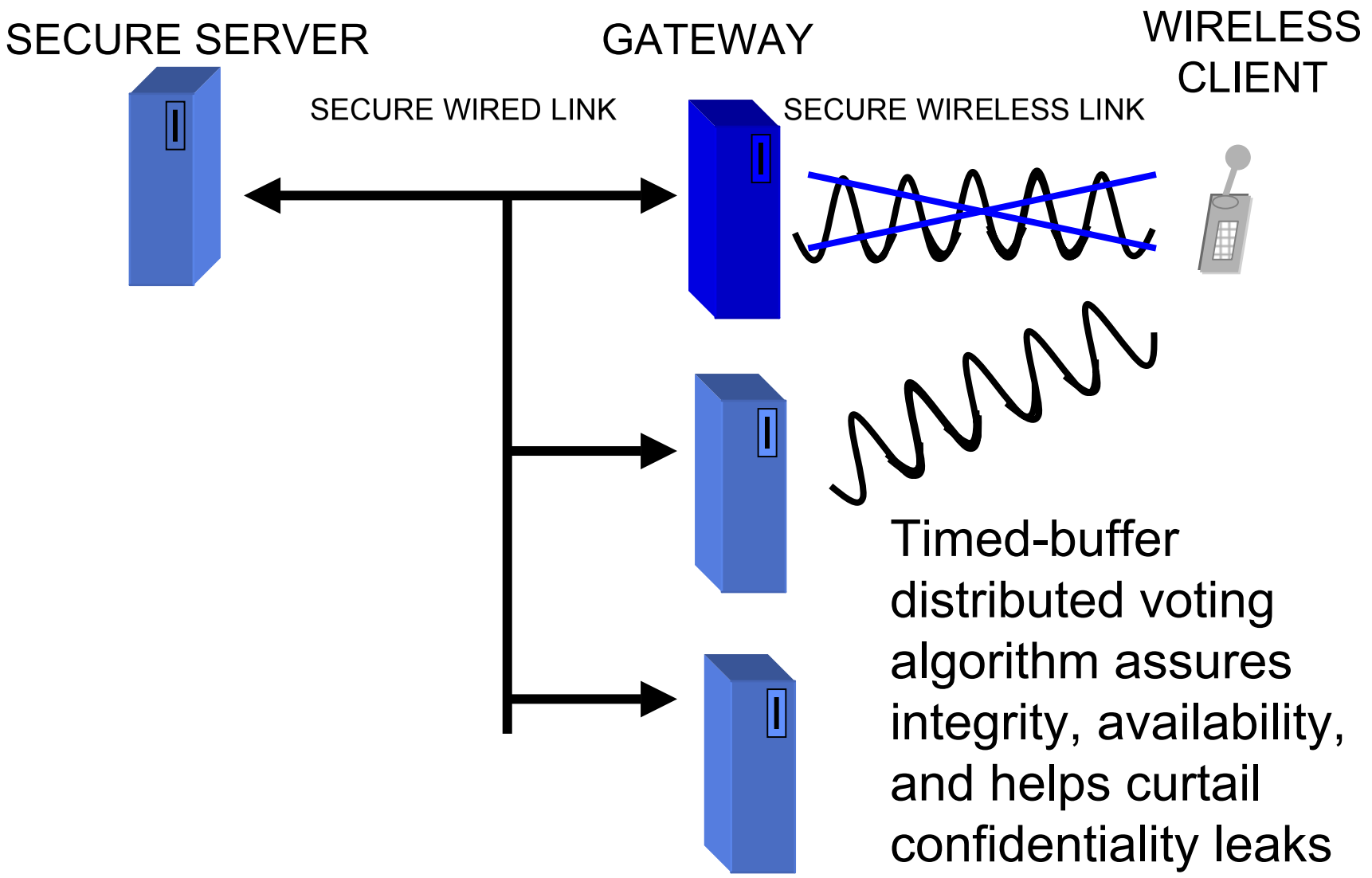
ACRC Application of TB-DVA



(when translated from IP standards to wireless and vice-a-versa)

- Apply fault tolerance techniques to protect, detect, and react to attacks and enable service restoration

Multiple Wireless Hubs



Timed-buffer distributed voting algorithm assures integrity, availability, and helps curtail confidentiality leaks

Conclusion

- **Problems Addressed**
  - **Security enhancement in distributed voting**
- **Techniques Used**
  - **Guaranteeing owner's intended result by distributed monitoring and voter isolation**