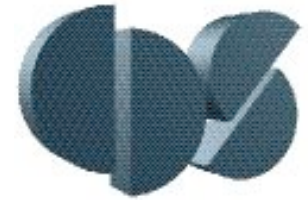




CS/EE/ME 75 – Team Caltech

25 September 2006



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**Engineering and Applied Science
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Meeting Goals and Agenda

Goals

- Provide an overview of the 2007 Urban Challenge and Team Caltech
- Describe the different ways to participate during the academic year
- Collect information on likely participants, including available meeting times

Agenda

4:30 Goals, Agenda, Notetaker
4:35 2007 Urban Challenge overview
4:50 Team Caltech: how to participate
5:15 Q&A
5:30 Adjourn

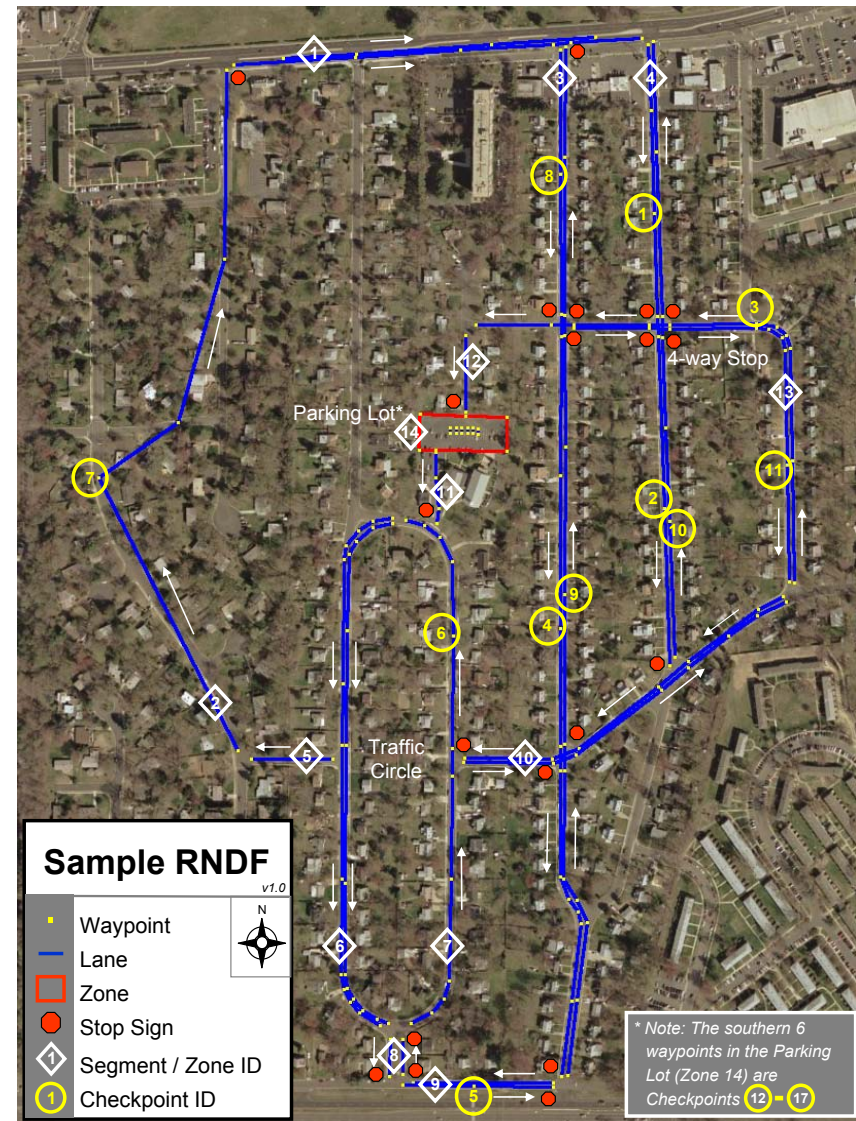
Notetaker: _____

- Record notes and action items from meeting; post on wiki

2007 DARPA Grand Challenge (Urban Challenge)

Autonomous Urban Driving

- 60 mile course, less than 6 hours
- City streets, obeying traffic rules
- Follow cars, maintain safe distance
- Pull around stopped, moving vehicles
- Stop and go through intersections
- Navigate in parking lots (w/ other cars)
- U turns, traffic merges, replanning
- Prizes: \$2M, \$500K, \$250K



Urban Driving

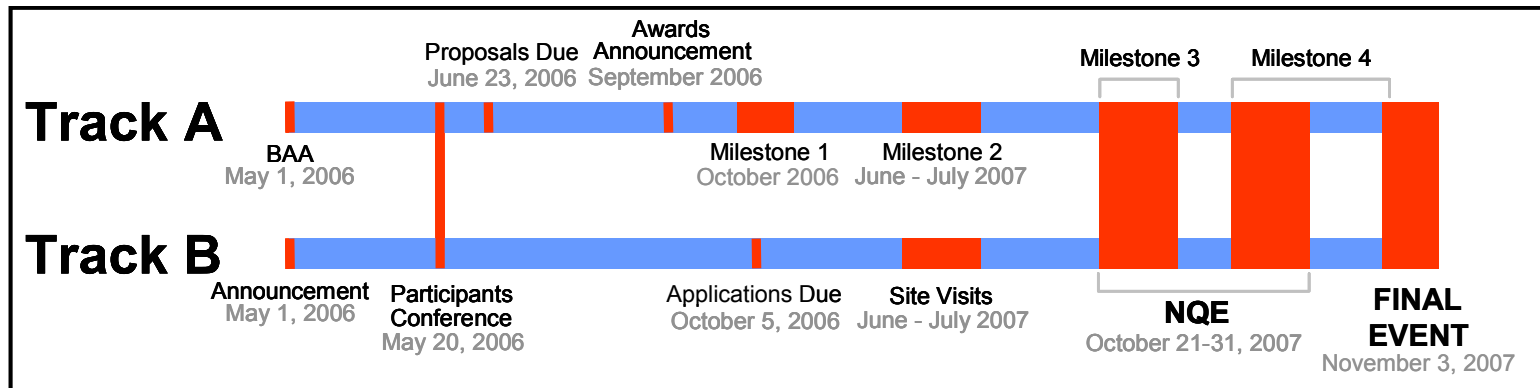


Video from 29 Jun 06 field test

- Front and side views from Tosin
- Rendered at 320x240, 15 Hz
- Manually synchronized
- Moving obstacle detection, separation, tracking and prediction
- Decision-making
- Lane markings (w/ shadows)

Some challenges

2007 Urban Challenge Participation



Track A: \$1M grant from DARPA

- Proposal due 23 June 2006; up to \$1M + any additional fundraising
- Award based on technical approach, management and funding plan, strength of team

Track B: no DARPA funding; similar to last year (application, site visit, NQE, GCE)

- \$50K award for getting to NQE, \$100K award for getting to race
- Application due 5 Oct, with video, technical paper due in Feb 07; site visits in Jun 07

Changes from last year

- Use of government resources OK with permission from sponsors

All participants in the race are eligible for 1st, 2nd or 3rd prize cash

Team Caltech

Team Caltech

- Started in 2003, for DGC04
- Over 100 undergraduates + grad students, faculty and volunteers

Alice

- 2005 Ford E-350 Van
- 5 cameras: 2 stereo pairs, roadfinding
- 5 LADARs: long, med*2, short, bumper
- 2 GPS units + 1 IMU (LN 200)

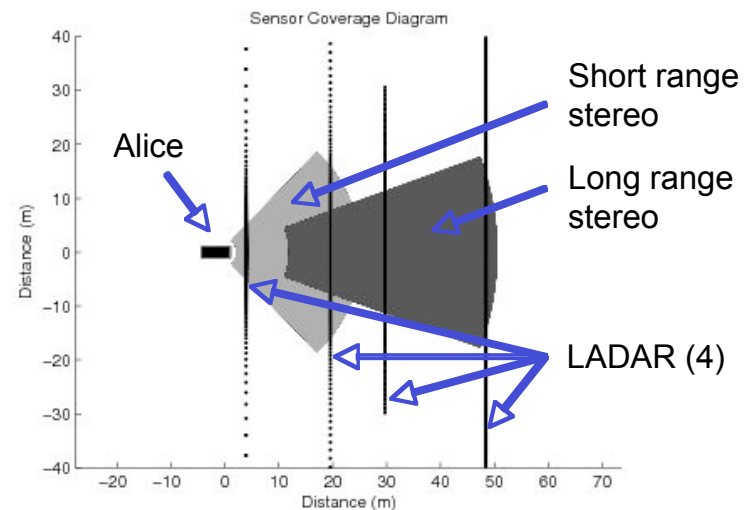


Computing

- 6 Dell PowerEdge Servers (P4, 3GHz)
- 1 IBM Quad Core AMD64 (fast!)
- 1 Gb/s switched ethernet

Software

- 15 programs with ~100 exec threads
- 100,000+ lines of executable code (good programmer does <100/day)

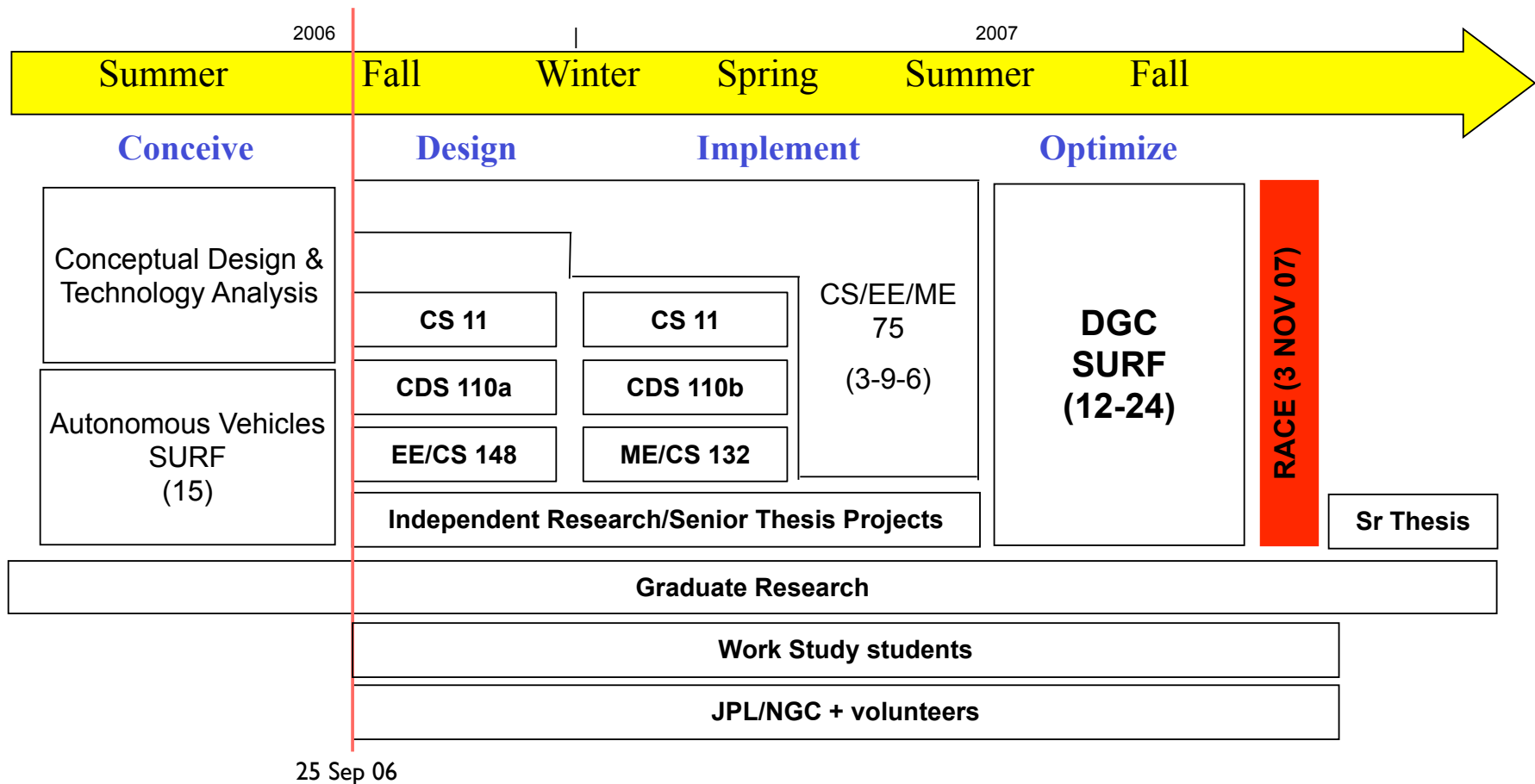




NORTHROP GRUMMAN

Team Caltech, 2006-07

**Goal: design, build and document
an autonomous ground vehicle
that can win the 2007 Urban
Challenge**



25 Sep 06

Linked Courses

First term

CDS 110a - control systems (9)

- Feedback control design
- Implementation project - driving and/or pointing system

EE/CNS 148 - machine vision (9)

- Course projects in feature and obstacle detection, vehicle tracking, etc

CS 11 - C/C++ programming (6)

- Basic or advanced C/C++ programming

Second term

CDS 110b - optimal estimation, control (9)

- Kalman filters and optimal control
- Implementation project - sensor fusion or real-time trajectory generation

ME/CS 131 (9)

- Path planning methods

CS 11 - C/C++ programming (6)

- Basic or advanced track

CS 11 - Multi-threaded programming (6)

- DGC-specific project
- Requires C/C++ programming

Participating in Team Caltech

Minimum requirements: 3-4 hours/week

- Attend weekly project meetings
- Attend weekly team meetings
- Learn about tools, processes, technology
- Undergrads: credit via CS/EE/ME 75
- Good way to learn more about project and prepare for future participation

Academic track 1: new to DGC, taking linked course

- Course project will provide opportunity to learn about Alice and technology needs
- Demonstrate possible technologies we might use through proof-of-concept stage

Academic track 2: new to DGC, *not* taking linked course

- Participate through (small) course project - HW, SW theory
- Identify candidate technologies for future development

Academic track 3: prior DGC (or equivalent) experience

- Participate through independent projects/research units
- Prototype implementation of technology on Alice

Implementation team: 10-20 hours/week (beyond classes)

- Dedicated team, working on Track A milestones
- Requires previous experience + *substantial* commitment

Work study (UG)

- 6 positions available
- Minimum 12 hrs/wk

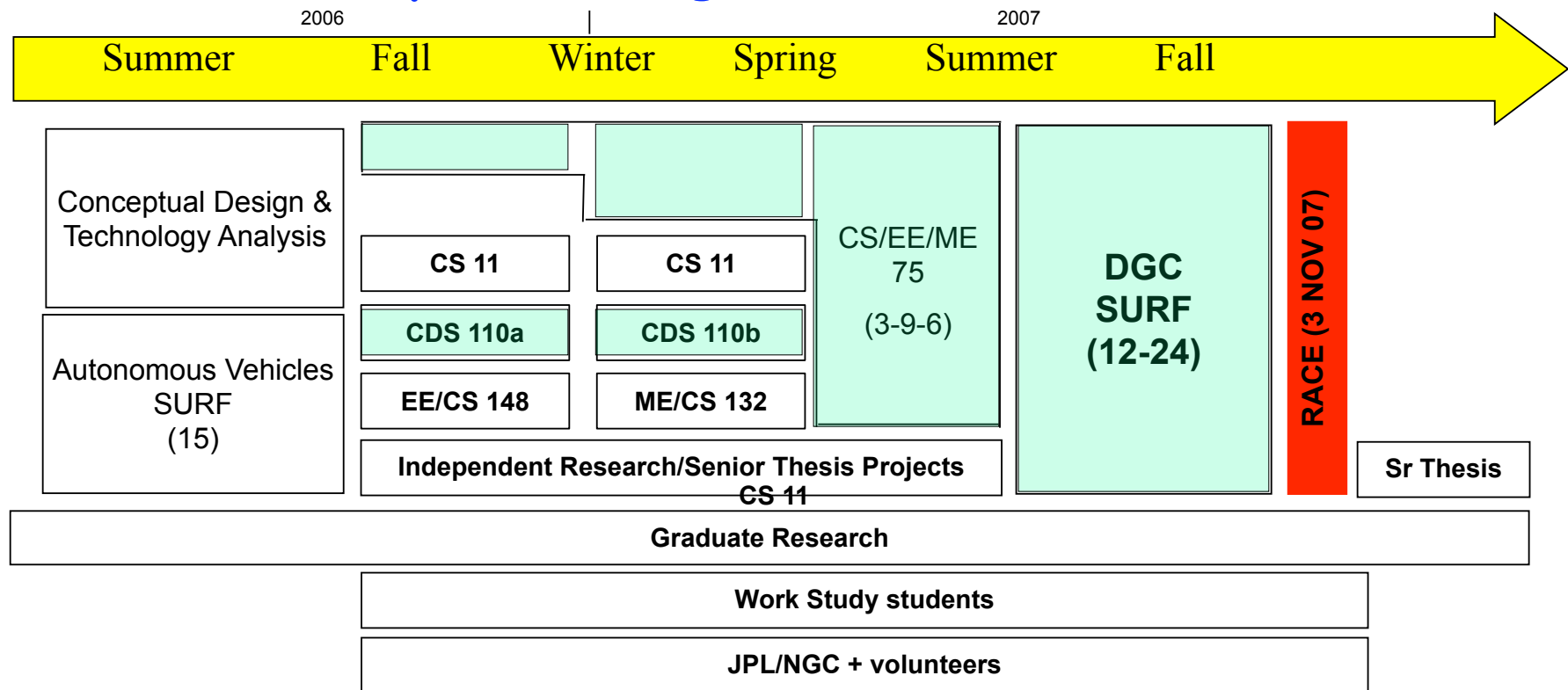
GRA

- Part-time positions; ask your advisor to contact RMM

Postdocs

- Project manager

Example: Undergraduate New to DGC



CDS 110ab - control systems

- CS/EE/ME 75: 3+ 6 + 18 units
- CDS 110a (9): motion control
- CDS 110b (9): sensor fusion
- SURF over summer

EE/CNS 148 - machine vision

- CS/EE/ME 75: 3 + 6 + 18 units
- EE/CNS 148 - vision-based sensing
- CS, EE or ME project in spring (9-12)
- SURF over summer

CS/EE/ME 75: Multi-Disciplinary Systems Engineering

Course “lectures” = Team Caltech project meetings

- Bring everyone up to speed on tools
- Team work: trade studies and design decisions
- Individual work: integration of “linked course” projects (track 1), small projects (track 2)

Wk	Topic	Reading/Homework
1	Organizational meeting	2007 Urban Challenge rules
2	Technology Inserting Process	GOTChA charts
3	Collaboration Tools	Wiki, bugzilla
4	Configuration Management	Subversion, YaM
5	How Alice Works	
6	Systems Engineering Team	
7	Operations Team	
8	Navigation Team	
9	Sensing Team	
10	Mission Team	

CS/EE/ME 75 Course Administration

Class homepage: <http://www.cds.caltech.edu/~murray/cem75>

Course meetings (first term)

- Project meetings: TBD (1 hr, weekly)
- Team meetings: TBD (1 hr, weekly)

Grading

- 20% Homework (weeks 3–6 only)
- 20% Team presentations
- 40% Documentation of work for the term
- 20% Participation (attendance, discussion, contributions)

Collaboration policy: full collaboration encouraged. Write up your own work.

Summary: How to Get Involved

1. Sign up for CS/EE/ME 75 (optional but strongly encouraged)

- 3 units to cover project meetings, team meetings, integrating activities
- Will teach tools for multi-disciplinary project engineering
- All students will be assigned to one of the primary teams
- First course meeting: Monday, 2 Oct (time TBD)

2. Sign up for affiliated courses: CS 11, CDS 110, EE/CNS 148

- Special sections/projects available for Team Caltech students
- Can take classes w/out being involved in CS/EE/ME 75

3. Sign up for work study

- Some tasks available; will not overlap with coursework
- Primarily work that is not part of course work (eg, vehicle maintenance)

4. Fill out Team Caltech signup sheet and turn in by Wed, 1 pm

**Everyone working on the project must be part of a team
and must attend weekly project and team meetings**