* **ythYour summary should comment on the following 5 bullet points with no more than 2 paragraphs each, entirely in your own words:**
* Summary (What were the major ideas and results described by the speaker?)
* of ype
* Strengths of the work (What were the noteworthy technical contributions presented in the seminar?)
* Weaknesses of the work (What were some technical shortcomings of the material presented?)
* Opportunities for future work (Describe some ideas for follow-on projects based on the material presented.)
* Presentation style (What did you like or dislike about the manner in which the speaker presented?)
* Notes:
* Part 1: Planetary cave exploration and JPL Tech
  + values: moons on Titan in good position
  + Scientists need layers of rock, or inside of crater (not surface data, we have that)
  + examples of entrance of cave
    - Rappling Robot
      * high TRL (tech readiness level)
      * modular, can split and rapple one part down to collect samples, other part analyzes
    - climbing robot
      * designed to climb walls
    - Mars Helicoptor
      * part of 2020 mission
      * tested in vacuum chamber, to see if can fly in thin mars atmosphere
    - Flying robot
      * low TRL
      * many together
      * communicate with each other
      * roller bot, to extend range and vehicle
* Part 2: Team-CoSTAR
  + latest DARPA challenge: subsurface exploration on earth
  + DARPA challenges
    - set ambitous goals, make novel approahces
    - achieve things that are high risk, high reward
  + SubT
    - 6 funded darpa teams
    - some private funded teams
    - 4 comps, 3 year effort
    - goemetric mapping
      * find objects in 8km long cave network
      * accurately give the location of the object
    - 3 years
      * various DARPA challenges over the years
  + Thrust 1
    - coss-domain mobility
      * 8km long subT env
      * 90 minutes operation
      * climbs/drops in narrow shafts
      * 1m in diameter passages
    - design: rolling quadcoptor
      * save battery
      * allow to fly when have to
  + Thrust 2
    - extreme navigation
      * check localization robustness on racing drones
        + because these are so agile, its a good test
      * Raced human vs their AI
        + human won, but they're trying to eventually beat it
    - localization challenges
      * dark
      * dust
      * high dynamic range
      * lightweight
      * robust
      * high frequency  
        + in general, use thermal, visual, and lidar
  + Thrust 3
    - resiliant communication
    - use low cost, less capable flying robots
      * carried in on ground robot
    - act as links
      * improve communication
      * also carry data as mules out to surface
  + Thrust 4
    - multi-robot situational awareness
      * collaborative mapping
    - Will determine who solve trust 4.
      * no one has in real world multirobot mapping
      * bad communication, so cant just send all the data of the mapping
  + Thrust 5
    - veritable autonomy
      * can report object locations to DARPA, and will tell whether the objects were found
      * This will help correct if your results is off
        + can keep asking, find where it is, and then use to correct
  + Thrust 6
    - mission planning, AI and machine learning
* Part 3: Robust and risk-aware motion planning
  + information control perspective
  + Autonomy Architecture
    - real world application
    - so resilience and robustness is needed
    - we have reason over uncert, and have accurate risk prediction
    - integrated perception and planning
  + Intrinsic autonomy
    - motion planning
    - mapping
    - localization
    - SMAP
      * SIMULTANOUS mapping and planning
    - SLAP
      * simultaneous action and planning
    - SLAM
      * use math to solve all positioning and planning at the same time.
  + Joint interface control
    - we have sensors with measurement and noise
    - we use an estimator
      * prob of any state given history of states
    - we have system
      * input action, motion noise
      * output: state
    - Action
      * takes in policy, gives out action
      * Information exchange
        + most likely state, plus confidence
  + CS view - this is a SLAP problem
    - discretize the space
      * we have state space and belief states
        + use a tree? outcomes grows exponentially
    - how do we beat this?
      * controller takes into account confidence, can look/take additional data, determine the truth of it
    - Use funnels, to get everything back to a possibility thats predefined
      * model is now linear into future, can predict the future with greater confidence
    - Use sparse representation of value states
  + SMAP
    - don't know the map
      * create map as you go. Then use map to find trajectory, but that map is based on the trajectory, cause that's how you know the map - traveling the trajectory
    - chicken and egg problem because
    - They use sensor-cause model
      * instead of inverse sensor model
      * what is probability that certain location in environment is the cause of the reading in measurements
      * can create recursive mapping frame-work
        + update belief over environment as travel
        + now, no longer object, have confidence
      * increased accuracy on classic data sets
        + shower a clear improvement
    - impact on planning
      * without SMAP
        + without considering uncert and perceptual capabilities
        + alternative

safe, but slow

* + - * + SMAP is

risk aware and fast

predict map evolution and use sensor readings